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# China Report

SCIENCE AND TECHNOLOGY



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11 July 1985

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EFFECTIVE MANAGEMENT OF SCIENTIFIC, TECHNICAL PERSONNEL

Taiwan JISHU JINGJI TO CHANGTIAN (RESEARCH ON THE ECONOMICS AND MANAGEMENT OF TECHNOLOGY) in Chinese No. 1, Feb 82 pp 48-51, 10

[Article by Bian Daping (4/08 1982 1427): "Making the Best Use of China's Limited Scientific Talents"]

[Text] The development of science and technology is governed by two laws. A very important one is that the more advanced, sophisticated and modern the branch of science and technology we are dealing with, the greater is the need for coordination on a social scale, and the smaller the probability of success through the struggle of a single individual. Any major achievements have must depend on the joint efforts of a pool of talent. However, giving full play to the abilities of each in the pool is basic to making the group as productive as possible. In fact, the two complement and interact with each other. Generally speaking, both the effectiveness with which we make use of the talent of an individual and the rationality with which we organize a community of experts depend on the sound management of experts.

Comrade Deng Xiaoping has pointed out, "The first step in implementing our policy on intellectuals is to sort out the management of our contingent of scientists and technicians." The management of people lies at the heart of any kind of management. Wedded to the use of administrative orders, some units currently still lack scientific methods in managing scientific and technical personnel, to the detriment of these people's initiatives. the practices of these units fall far short of the requirements of fulfilling the nation's intellectual policy. (See Fig. 1)

	2.33	8.43	3.23	21.17	8.61	
method	patient guidance	democratic consultation	paying attention to personnel work	using admin. orders	trust worker, give him free hand	
	11.17	17.84	9.7	21.53	7.08	5.14
method	short on support, long on criticisms	non-interference	shuffling off responsibility to workers	leaders interfere in everything	major issues discussed by group	cultivate relations with subordinates

Fig. 1 identifies a widespread problem, namely, that among management methods, "patient guidance" and "paying attention to personnel work" are the least in use.

Our four modernizations require a constant flow of scientific and technical achievements, but it is grossly inadequate merely to ask scientific and technical personnel to do their best under trying conditions. To a large extent, after all, scientific and technical innovations cannot be understood in isolation from a set of necessary external conditions, of which an essential one is a correct attitude towards scientific and technical personnel.

Our survey findings suggest that a considerable number of units lack just such an attitude. (See Fig. 2)

Fig. 2

Percentage	2.45	25.47	15.26	4.2	42.34	3.48
Attitude	utter devotion	regarding workers as reliable	workers to be used, not trusted	keep workers at arms' length	deal with workers only when problems come up, otherwise ignore them	regard workers as target of educational reform

From now on the goal of the management of scientific and technical personnel is to "get to know them well enough to assign them jobs commensurate with their abilities."

#### 1. To "Get to Know Them" Means Probing Into Their Circumstances

As the ancients said, "We cannot use a person if we do not know his weaknesses and strengths." Today at a time when the focus of party work



is shifting towards socialist economic construction, it behooves us even more to open our eyes to the strong points of our intellectuals and the vital role they play in the four modernizations.

#### (1) Understanding Intellectuals' Social Position and Roles

Intellectuals' social position and roles are determined by objective realities and the needs of the four modernizations. They cannot be either exaggerated or disparaged by the leaders of a certain unit. As contemporary science and technology surges ahead and poses us a challenge in the form of the new technological revolution, we must make it our top priority to recognize the reasonable social position of scientific and technical personnel and utilize to the full their vast potentials.

#### (2) Understanding the Quality of Scientific and Technical Personnel

Scientific and technical personnel share one characteristic with other intellectuals: a penchant for speaking their minds, which often gets them into unpleasant situations or worse and militates against the flowering of their initiatives. Actually, their independent-mindedness is exactly a manifestation of their thoughtfulness, analytical abilities and their sense of responsibility. They may be imperfect in one way or another, but we must not lose sight of their dedication to the nation and appreciate their strong points. As Li Shimin, Emperor Tang Taizong, said, "A gentleman employs people the way he uses instruments -- by making use of the good points of each."

#### (3) Understanding the Peculiarity of Scientific and Technical Work

As the work performed by scientific and technical personnel is exploratory and innovative, we must not set stringent requirements concerning their achievements. Comrade Zhou Peiyuan [0719 1014 3293] said, "Scientific research needs support first and foremost. The mistakes and failures which occur in the course of scientific research are inherent in scientific development and cannot be avoided. There is no overnight success in scientific research; it takes times to determine whether or not a theory or a viewpoint is valid." As a result, we must give the work of our scientific and technical personnel the respect, active support and sincere trust that they deserve.

#### (4) Understanding the Needs and Thinking of Scientific and Technical Personnel

Figure 3 gives us an idea of their needs and thinking, based on the feedback obtained in our survey.

44. 912	79. 172	2. 142	7. 222	46. 142	17. 122	11. 242	12. 242	14. 112	17. 242
title and rank problems	heavy family responsi- bilities	low salary earnings	scientific work gets less than any	degree less than	work more valuable than of work	work more valuable than of work	all technical work	heavy responsi- bilities more valuable than of work	scientific work, job problems of work more valuable than of work

Fig. 1

(1) Legally established job titles reflect where a scientist or technical worker stands on the career "ladder" and is an overall indication of his achievements, professional standing and practical abilities. Our research has revealed that our present system of determining the status of personnel is generally inadequate and discriminates in favor of academic qualifications, almost to the point of relying solely on "university diplomas." Scientific and technical achievements themselves are already the concrete embodiment of expertise, blending book learning with applications. If we continue to stress paper qualifications in determining a worker's rank or title, our scientific and technical work will move further and further away from our aim of translating scientific and technical endeavors into productivity. This deviation runs counter to our magnificent construction goals for the year 2000.

(2) Since the late 1950's, we have been underpaying our college graduates. If we compare the earnings of intellectuals and workers of the same age, while their basic wages are about the same, the latter's bonuses and overtime pay are much higher than the former's. Intellectuals shoulder heavy responsibilities at work and at home. Some of them are in failing work. All these problems should be taken seriously.

To fully mobilize the enthusiasm and initiative of scientific and technical personnel, we have no alternative but to really get to know their quality, roles, characteristics, needs and thinking and take further measures to change policies, systems or organizations.

## 2. "Assigning Them Jobs Commensurate With Their Abilities" Means Discarding Prejudices, Considering Merit the Sole Criterion in Appointing People and Making The Most of a Person's Talents

Comrade Nie Rongzhen [5119 2837 5271] has pointed out, "Making proper use of people is a big issue. In a battle, if you put the wrong people in the field, you will end up with more casualties. Should we fail to use China's scientific and technical workers properly, and there is not an awful lot of them to begin with, we will be extremely wasteful."

### (1) Paying Attention to Group Structure

Modern scientific and technical achievements are increasingly dependent on

The consideration of technological modernization and growth requires that we measure, first, human resources and technology, as getting more and more specialized even while in response to the same time a high degree of flexibility, and second, as the large human contingencies become more and more flexible teams. Increased scientific and technological knowledge and capabilities. There is only so much knowledge and so much personnel can come, which explains why the only resource is gradually getting to be a dying breed.

## (2) Strengthening the Training and Exchange of Scientific and Technical Personnel

Without experts, there can be no scientific achievement. As we confront the new technological revolution today, we must attach extremely importance to such questions as the life long education of scientific and technical personnel, the attitude prevailing of younger workers and particularly the development of experts in the new branches of science.

The training of scientific and technical personnel requires that we upgrade their theoretical knowledge, on the one hand, and attach to them assignments of the necessary degree of complexity, on the other, thereby applying the principle which we often talk about, "giving people assignments even while training them." In this way we will enable our limited scientific and technical forces to keep outdoing and making themselves useful to the greatest extent possible.

Scientific and technical personnel have many worries, including wages, livelihood and working conditions. But what is uppermost on their minds is their career prospects. There is a widespread demand among them for a certain measure of mobility. Our recent survey comes up with a number of factors blocking the mobility of experts, the major ones being confused detailed policies and the proprietary interest that units take in their personnel, considering their departmental possessions:

35.15%	18.63%	15.68%	10.38%	24.75%	11.13%	8.28%
ownership by unit	conservative leaders	large gaps in wages	no unit to act as go-between or pull strings	confused policies	each unit has its pulses, minus-	incorrect ideas among administrators

Fig. 4

In short, we should institute a sound management for our scientific and technical personnel, which will mobilize their enthusiasm as well as getting the most of limited scientific and technical forces, and transform the irrational structure of our scientific and technical contingent so that it can soon meet the requirements of the four modernizations.

## NATIONAL DEVELOPMENTS

### DEVELOPMENT OF YOUNG, MIDDLE-AGED S&T PERSONNEL ROLES ADVOCATED

Tianjin KEXUEYU KEXUE JISHU GUANLI [SCIENTIOLOGY AND MANAGEMENT OF SCIENCE AND TECHNOLOGY] in Chinese No 2, 12 Feb 83 pp 10-11

[Article by staff commentator: "Another Appeal for Young and Middle-Aged Scientists and Technicians"; responsible editor: Zhao Beiwang [6392 0534 2598]]

[Text] A great upsurge in economic system reform focused on the cities is now sweeping across the Chinese mainland. Along with this historically significant change, all professions have been increasingly manifesting more urgent demands for science and technology (S&T). Thus, fully developing the roles of existing young and middle-aged scientists and technicians has become an extremely important strategic problem related to China's four modernizations and a very important aspect of S&T system reform.

In the 35 years since the founding of the PRC, a generation of young qualified scientists and technicians trained and led by the older generation of scientists has reached maturity, and this is a major sign of the inevitable vigor and prosperity of our cause. Young and middle-aged research technicians under 50 years of age have now become the nucleus of all S&T work, and problem group leaders and people responsible for projects in all units are almost all young and middle-aged; those who have won S&T awards from the state, ministries, commissions, provinces and municipalities since 1978 have also been mostly young and middle-aged. Young and middle-aged scientists and technicians have become the majority of China's S&T ranks and are the main force and vanguard who can be fully trusted politically and fully relied on to carry out the work of the four modernizations and the connecting link in the bridge ensuring that China's S&T will be able to thrive and prosper constantly.

But the roles of young and middle-aged scientists and technicians are still far from having been fully developed, and this is an important problem that deserves attention, that needs to be studied and that is in urgent need of being solved. Based on a 1983 sample investigation by the Chinese People's Scientific Consultative Conference of over 30,000 young and middle-aged scientists and technicians throughout China, only a fifth have developed their roles well, three-fifths have partially developed their roles and the other fifth have not developed their roles for a variety of reasons. The major factors restricting the full development of the roles of young and middle-aged scientists and technicians are:



1. The lack of a fair competition mechanism and scientific evaluation criteria has resulted in the fairly common phenomenon of young and middle-aged scientists of "40 years being unable to assume power and 50-year-olds not being in positions to make decisions."
2. The spiritual encouragement mechanism has withered and professional titles have become "years-of-service alignments."
3. The material encouragement mechanism is out of order and pay for mental and physical labor is reversed.
4. Good and essential working and living conditions are lacking.

Talk of carrying out a policy on intellectuals has become very familiar over the past few years, but the problems of professional titles, working conditions and pay have not been thoroughly solved. We think that it is most important that leaders at all levels truly and thoroughly understand the value of knowledge, stress the great social role of intellectuals who are regarded as a link between S&T and economic construction, carry out the policy in actual situations and use as many funds as possible to solve the problems of the intellectuals' working conditions and living expenses. We must attend to the intellectuals' actual problems on a large scale and not just "publicize" a few typical cases.

At the U.S.-China S&T Policy Symposium held in the U.S. in 1984, the U.S. side proposed several "evaluation views," saying that "you have talked about carrying out a policy on intellectuals for quite a few years but we do not know to what specific degree it has been carried out. Can it be measured?" They said that "Our U.S. 'policy implementation' is mainly expressed through 'giving money.' The so-called policy is fund allocation. We think that your talk in China about carrying out a policy on intellectuals year after year means increasing the fund allocation to intellectuals year after year...." Is it not known that our pay for mental and physical work is still reversed? Disregarding the one-sidedness of the U.S. views, our present major task is indeed to use all economic levers and to carry out all S&T policies in actual situations.

In order to develop as quickly as possible the roles of young and middle-aged scientists and technicians and tap their huge latent potentialities, we will have to adopt a series of synchronized and complete policies such as:

1. Premised on respecting knowledge, ability and qualified personnel, establishing a rational mechanism to screen and select qualified personnel through "reform" is the basis for solving the problem.
2. In order to promote the overall work situation, we should quickly lower the average age of the academic, technical and management department policy-making layers at all levels, replenish academic and technical leading organs of all types and at all levels with outstanding young and middle-aged key S&T elements and allow them to assume power and play leading roles. We should raise the proportion of key young and middle-aged S&T elements among deputies to the National People's Congress, CPPCC committee members and delegates to the 13th CPC Congress.

3. For important people who have won national natural science awards, national creative invention awards and grades 1 and 2 Chinese Academy of Sciences, departmental, provincial and municipal S&T results awards; for those who have acquired Ph.D's in the past few years both in China and abroad and proved that they are truly successful through 2 or more years of S&T work practice; for those who have published up-to-standard academic papers in the past few years and have been recognized and quoted by experts in the same field both in China and abroad; as well as for scientists and technicians who have actually guided graduate student work in the past few years, regardless of the depth of their qualifications and records of service, we should resolutely, boldly and promptly raise their professional titles to high levels.

4. Most of the people who are responsible for problem groups and projects are now young and middle-aged, and in order to develop their roles fully, we must give them autonomy in setting up problems, allocating funds, deploying personnel, giving rewards and punishments and carrying out daily management based on the principles of separation of party and government and separation of government and research. Institute and laboratory leaders should mainly exercise the functions of coordination and leadership and not directly command and interfere in the research work of problem groups.

5. The state must allocate special funds, the Chinese Academy of Sciences and all departments, provinces and municipalities should set up special funds and in order to encourage and subsidize outstanding young and middle-aged scientists to make special contributions, they should be given special support and must be boldly rewarded. Graduate students who go abroad to study should be given pay which corresponds to foreign living standards and is necessary to engage in social contact. All scientists and technicians who are totally subsidized by foreign countries to go abroad to study, attend meetings and give lectures must not be obstructed from leaving China under any pretext.

6. All units must create the conditions to attract qualified personnel and not put obstacles in the way of qualified scientists and technicians who have difficulties in developing their roles in their units and who request transfers.

7. All units should take the position of encouraging scientists and technicians to make more contributions to society and deal with problems of concurrent posts and spare-time concurrent posts. Units which have "pupils" everywhere (referring to those which disseminate technology and train qualified personnel) and high social results should be given to material and spiritual rewards. Units which persist in carrying out a "closed style" must be given economic sanctions in areas such as taxes and profits.

8. Prior to wage reform, all units should adopt methods such as post subsidies and rewards and should first solve the income problems of some young and middle-aged key S&T elements who have made achievements and contributions.

9. We should create good social conditions and habits and support qualified personnel who boldly blaze new trails. If a society or a nation cannot tolerate and support qualified personnel who have new ideas and creative ability but can only support so-called impeccable people who have no creativity, it will

inevitably develop slowly and lack competitive ability among the nations of the world. Propaganda departments and news units should therefore vigorously publicize vivid examples of young and middle-aged scientists and technicians who have made outstanding accomplishments on all fronts, expose those conditions which suppress, attack or smother the growth of young qualified scientists and technicians and create a good social environment suited to the growth of qualified personnel.

The above-mentioned measures were established on the basis of fully confirming the outstanding contributions made by the older generation of scientists. They are both emergency measures and ones which must be carried out over a long time, and it is most important that leaders at all levels carry them out in actual situations.

The S&T market has gradually been invigorated over the past few years and this has been an inevitable result of the development of coordination between S&T and the economy and society. It has also provided the possibility for all departments to improve the working and living conditions of intellectuals. Technology must enter the market in great quantities, have the properties of commodities and obey the law of value. S&T management departments at all levels must break free as quickly as possible from overcentralized management methods, change purely administrative relations into ones in which economic contents are the major factor and learn to use all economic levers to regulate and manage. Only a new type of S&T management cadre who understands technology, has accepted specialized training in modern management, is economically minded and has an enterprising spirit will be able to use a reform attitude to develop fully the roles of the masses of young and middle-aged scientists and technicians.

Let us take positive action to strive to create a brand-new situation in which people of talent come forth in large numbers and science prospers.

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CSO: 4008/333

NATIONAL DEVELOPMENTS

MACROSCOPIC SCIENTIFIC RESEARCH, EDUCATION REFORM TACTICS EXPLAINED

Tianjin KEXUEXUE YU KEXUE JISHU GUANLI [SCIENTIOLOGY AND MANAGEMENT OF SCIENCE AND TECHNOLOGY] in Chinese No 2, 12 Feb 85 pp 29-31

[Article by Zhao Yingbo [6392 3602 3134] of the Anhui Social Sciences Academy: "Macroscopic Scientific Research and Education Reform Tactics"; responsible editor: Zhao Beiwang [6392 0554 2598]]

[Text] In order to develop intellectual resources and increase social wealth, it is necessary to do a good job of reforming scientific research and education departments. How to develop their socioeconomic functions fully, thus enabling the whole social economy to achieve the greatest macroscopic results, is a macroscopic tactic in reforming scientific research and education and also an objective criterion for testing the success of reform. If a reform only enables departments to make profits but does not fully develop their socioeconomic functions or even damages their macroscopic results, it will not be successful. Only if macroscopic reform tactics are correct can microcosmic departmental reform be very successful.

Even though many factors prevent science and technology (S&T) and education from developing their economic functions, the author still believes that if several bridgeheads are captured through reform, the "sources of social wealth" will be able to emerge fully.

1. S&T Must Form Systemic Socioeconomic Circulation Links

The product of a scientific research department is its scientific research results and in order to enable it to conform to social needs and achieve economic results, it will be necessary to do a good job of the work of marketing its products in advance and to avoid blindness. Choosing the right problem is half of its success, and knowing what society most needs studied is more important than knowing how to study. But the fact that many scientific research departments do not study market prices, do not solicit opinions and information on problem design from the necessary parties and work behind closed doors is a major reason why the survival rate of scientific research results is so low.

Thus, it is necessary to draw practical departments and production units into participating in discussions on "problem design" and supporting scientific research plans. In addition to publishing "difficult S&T problem bids" in the



newspapers, it will also be possible to start special columns such as "Lists of Actual Problem Choices," "Problem Design and Marketing in Advance" and "Liaison Information, Cooperation Channels and Scientific Research Contracts" in all academic journals and to establish contact channels. All those who have originated the discovery of new problems, proposed new problems and carried out good problem design should be regarded and officially recognized as scientific research results.

Increase is not equivalent to development, and the constant renewal of technology is the source of life in developing the national economy. It is necessary to predict and calculate the economic lifespan of existing technology in a regular manner in order to achieve the greatest economic results and formulate a strategy for renewing technology. Socioeconomic development must constantly propose new problems for S&T departments, effective S&T development must promote socioeconomic development and S&T work must fully develop its function of forming systemic socioeconomic circulation links in order to develop successfully.

## 2. Education Forms Systemic Socioeconomic Circulation Links

Education develops its function by combining S&T knowledge with people's intelligence, and the products of education are qualified graduates suited to social needs. Qualified personnel are formed of the two areas of people's ability and social needs. Improving the qualification rate should be the major goal of education in contributing results to the national economy, and striving to enable educational planning to suit socioeconomic development needs is the major way in which education plays its role in the national economy. Only through reform, which enables the types and number of educational products to be coordinated with actual socioeconomic needs, can education effectively develop through forming systemic socioeconomic circulation links.

In order to improve the qualification rate, it will be necessary to enable education departments to be integrated with social needs and to do a good job of marketing educational products in advance. Units which use personnel should not distribute products to qualified personnel free nor should colleges blindly produce and rely on a "free fund-allocation life." Based on their development plan needs, regions and enterprises should make appointments with colleges to engage a specific number of specialized graduates suited to their needs and standards, sign contracts and carry out reimbursable distribution and direct recruitment to anticipated results. (Xian University has decided to try out this reform.) Thus, education plans and curricula not only should be the business of educational units but must be discussed with social personnel departments and jointly formulated with socioeconomic planning departments. Socioeconomic development promotes changes in the development of educational plans and curricula, and the effective development of education also promotes socioeconomic development. Education forms systemic socioeconomic circulation links which promote their mutual development. The key to why education is regarded as nonproductive, is not valued and develops slowly is that it does not make profits. If a good job is done of marketing educational products in advance and replacing traditional "government-run education" with management-type education, all problems will be readily solved. Problems of jobs being suited to specialties, colleges and technical high schools

being in proper proportion and education being suited to development can all be automatically coordinated and solved through "marketing in advance" consultations with units which use personnel. But education departments will still have the problem of how to calculate properly the magnitude of the value of educational labor and fair prices for education products. Education cannot only look at its own departments when considering problems but must study a series of jobs in order to reform them based on developing their socioeconomic functions and on their social effects; this macroscopic reform will inevitably result in colleges carrying out a series of reforms "favorable to developing the social productive forces" such as qualified personnel cost accounting, a qualified personnel training job responsibility system, qualified personnel quality differential evaluation, qualified personnel economic results predictions, rational matching of qualified personnel composition, directed recruitment and selection of the best to train.

### 3. Reform of the Method of Recruiting and Training Graduate Students

Whether people can be encouraged to contribute more to the country through study and whether more people can be attracted to integrate their studies conscientiously and concretely with national construction and overcome the phenomenon of studying only to achieve an academic record is the key to improving the educational qualification rate and a major problem in finally developing the role of education in the national economy.

Many college graduates who think they can still advance are now busily taking examinations for graduate school, but the enrollment rate is very small and it is difficult to say whether the great amount of energy spent year after year is very significant to national construction and social development. Many graduate students who graduate each year "do not live up to their potential" and are a great waste of intellectual resources. Ph.D.'s in foreign countries who are hired as chauffeurs or even unemployed after graduating are indeed not a rarity and there are approximately 5,000 unemployed "wasted Ph.D.'s" in Japan alone; although they can all be assured of full employment in China, if the actual role of some of them in the national economy is no greater than that of chauffeurs, how can this not be a form of concealing the waste of educational investment?

From an overall view of history, there are two kinds of examination papers, one being small examination papers to examine the best students in a field or graduate students and another being large examination papers in line with the age of socioeconomic development. The phenomenon of large and small examination papers being divorced from each other regularly appears. Due to the aging of textbook knowledge, those who can make 100 points on small examination papers often can only make 30 points on large ones. In order to overcome as much as possible this lack of coordination, there have been a large number of idealistic people in every age who have boldly established new knowledge structures through independent study in order to adapt to new needs, successfully contributed their strengths to social development and achieved high grades on the test of the times. There has been no lack of such examples among natural and social scientists both in China and abroad throughout the ages; China's older generation of revolutionaries boldly established a new knowledge structure in the 1930's through independent study and combining the acceptance of Marxism-Leninism with China's practice, thus successfully realizing socialism in China. At this late hour,

the tide of the new technological revolution has been attacking the traditional industrial and knowledge structures, and a large number of new problems have appeared in the process of socioeconomic modernization which require the carrying out of much comprehensive interdisciplinary research. We must stress this positive and significant independent study and adopt many effective measures to encourage people to make high marks on the test of the times.

There are two kinds of independent researchers, one kind who focus on courses and the other on problems. The study scopes and knowledge structures of the two are different. The policy of making the former participate in higher education independent study examinations, recognizing the academic records of the qualified ones and issuing them credentials is very fair. But making the latter participate in similar examinations cannot develop their distinctive characteristics since many new problems are not part of the traditional disciplines. In this age of the constant emergence of new disciplines, more attention must be paid to encouraging positive and significant independent study to focus on problems. So-called diplomas are only proof of study experience and expressions of a specific amount of knowledge. The study experience of independent researchers who have achieved scientific research results is longer, and although their study scopes are different, the amount and extent of their knowledge are not less than those of college graduates. Results represent their academic records and they are much more important than diplomas. Hefei heavy-duty machine plant worker Zou Suijun [6760 4482 0193] invented 9 sets of high-efficiency industrial jigs; Deng Youping [6772 0645 1627] of the Jingmen municipal party committee propaganda department published over 10 papers in academic journals, a number that is higher than the provincial level, through independent study; a technical high school graduate thought up "mass economics" through independent study and attended an international academic conference; and many independent researchers have also contributed results to the country through spare-time study. Among them are some who have the ability or have missed the opportunity to take examinations for graduate school, but in order to study new problems for which the age urgently needs solutions, they have boldly made sacrifices and set forth on this difficult and risky route. But many of these spare-time researchers who have achieved results are still struggling in difficult situations or are suffering from certain forms of discrimination. Thoroughly solving this problem as quickly as possible and enabling people to see ways to make personal contributions will have a positive effect throughout society.

In order to solve this problem, we cannot rely only on occasionally encountering help from certain enthusiastic experts but should rely mainly on policy solutions. The socialist system itself should be and is fully capable of becoming the best trainer. To this end, I suggest developing a new way to recruit and train graduate students: to make an annual statistical report to the leadership on independent researchers who have achieved scientific research results (including popularizing imported technology) or a specific number of minor reforms to send them based on the degree of their results and exempt from examination to engage in advanced studies in technical high schools, colleges, universities and graduate schools, respectively, and to stipulate which class of achievement diplomas are equivalent to which class of academic diplomas. The training method should be based on their distinctive characteristics, allow them to supplement and perfect their knowledge structures based on their new research plans and give them greater



freedom in choosing problems. After completing their elective course plans, they can be given graduate diplomas based on their examination grades or their newly obtained results. Creating this kind of a new recruitment channel will of course be favorable to producing more qualified personnel and quicker results. Those who invent new technologies abroad can gain a large amount of income; we cannot pay them as much in China, but giving them an opportunity to engage in advanced studies is entirely possible. If a province or municipality can take a first step to recruit spare-time researchers throughout the country who have achieved results to engage in advanced studies and training and then distribute them to work suited to their special training, it will definitely result in great advantages for economic progress.

#### 4. Results Should Be Used To Evaluate Professional Titles and Theses to Win Academic Degrees

Professional titles are evaluated in order to facilitate the organized carrying out of professional work based on the various actual work abilities and technical levels of intellectuals. They should be differentiated according to such things as their credit to society, distribution according to work and academic records. Professional titles do not represent contributions, since a comrade who willingly bears the burden of office and does a lot of work can be honored as a model worker but cannot be given a professional title higher than his technical work level; nor do professional titles represent the amount of work, because if an intellectual with a fairly high professional title does not do positive work, it will be difficult for him to create very much social value and he should not receive a very high reward (including wages and income); nor can professional titles be equated with academic records, because the current method of regarding technical and professional titles as appendages to academic records and the lack of academic records as a block to professional titles is unfavorable to the development of S&T work. If a person with a fairly extensive academic record has not developed a fairly high technical level in actual work, he cannot be evaluated as qualified for a fairly high technical or professional title, but if one with no academic record or with a minor one has done assiduous independent research and achieved many scientific research results or developed a fairly high technical level in actual work, he should be given a corresponding technical or professional title based on the number of results or his actual technical level. People are not perfect nor is talent always versatile; when evaluating professional titles, regulations must not be set too rigidly, that require for instance that foreign language tests be passed, and those with outstanding scientific research results or professional levels may be promoted without exams. The policy of regarding scientific research results or actual technical work achievements as the only criteria for evaluating technical and professional titles must be carried out in order to benefit the full development of people's intellectual potential and the proper organization and coordination of the intellectual strength ranks and to serve the development of the national economy.

In foreign countries, if a submitted thesis passes review and a Ph.D. dissertation is defended, a doctorate can be acquired, but it is now necessary in China to undergo Ph.D. graduate study in order to be permitted to submit doctoral



dissertations. These doctoral dissertations are often inferior to the papers published by certain experts in domestic academic journals, but these experts cannot obtain doctorates. An academic degree is an academic standing approved through a stipulated evaluation procedure; it cannot simply be a progressive increase of an academic record nor is it an evaluation of work ability but can only represent an evaluation of actual academic level and attainment. Abandoning formalism, adopting a realistic attitude, reforming the present domestic academic degree system and conferring academic degrees on a large group of Chinese specialists and scholars who actually have doctorate or masters levels will certainly raise their spirits, arouse their enthusiasm to develop science based on their spiritual interests and encourage their successors to strive to raise their actual academic levels.

In summary, although S&T and education department reform are far more complex than rural and enterprise reform, provided we conform to the spirit of the 3d Plenum of the 12th CPC Central Committee's decisions on reform and based on comprehensive and conscientious study, strive to carry out a series of beneficial reforms, clean up all the bad habits of formalism, eliminate all factors which suppress enthusiasm, dismantle all bars, fences and fetters which obstruct progress, enable "people's work results to be closely linked to their social credit and material interests" and allow the rules of the road for progress to be broad and all sources of wealth to be able to emerge fully, we will certainly be able to initiate the condition of going full steam ahead, fully develop all the strengths of S&T and education workers and make a greater contribution to promoting the successful development of the national economy.

12267

CSO: 4008/333

APPLIED SCIENCES

CHINA'S FIRST IMPORTED PERIPHERAL EQUIPMENT PRODUCTION LINE

Beijing JISUANJI SHIJI [CHINA COMPUTERWORLD] in Chinese No 11, 8 Jun 84  
p 1

[Article: "Ministry of Electronics Industry's Computer Bureau Sets Up I Modernized Disk Drive Production Line"]

[Text] A disk drive production line imported by the Computer Management Bureau of the Ministry of Electronics Industry from the French Electricity and General Company was formally checked and accepted by the Hunan Huaihua Jiannan Electric Equipment Plant at the beginning of May.

This production line was a national key import and is of an advanced level abroad as of the late 1970's. The entire production line is made up of over 10 departments including precision machine processing, electronic manufacture, overall assembly, and testing, and includes over 20 pieces of imported equipment, over 260 pieces of domestically manufactured equipment, and has the capability to produce 500 model ZPC-204 hard disk drives and 3000 ZPC-3 floppy disk drives. The entire process, from the checking and acceptance of entire machines, and the testing methods are all advanced and for the most part are controlled by computers and microprocessors. The plant building adopted an air-conditioned corridor internal design and moveable walls, which is attractive, tasteful, and very flexible. The air-conditioned and purified plant area is over 3,000 m<sup>3</sup>, production equipment is of the early 1980's level, and the production environment is of the modernized level.

This is the first peripheral production line China has imported and it has changed the manual work style in production of magnetic recording equipment in China, established the technological, material, and personnel foundation for new production and will greatly promote the development of China's computer industry.

8226  
CSO: 4008/1024

APPLIED SCIENCES

PIEZOELECTRIC INERTIA SENSOR DESCRIBED

Beijing DIANZI KEXUE JISHU [ELECTRONIC SCIENCE AND TECHNOLOGY] in Chinese  
Vol 15, No 1, 10 Jan 85 pp 11-13, 24

[Article by Zhang Fuxue [1728 4395 1331]: "Piezoelectric Inertia Sensor"]

[Text] The piezoelectric gyroscope is a new type of solid-state inertia sensor which utilizes crystal piezoeffect sensitive angle parameters. The piezoelectric gyroscope has eliminated the rotating part of the traditional gyroscope and thus obtained an important breakthrough in gyroscope life, the MTBF has reached over 10,000 hours.

Based on the initiative of Professor Qian Xuesen [6929 1331 2773], in 1970 China began to develop the piezoelectric gyroscope, and it is now widely used in space flight, aviation and at sea.

Oscillating-beam-type Piezoelectric Angular-rate Gyroscope

The working principle of the oscillating-beam-type piezoelectric angular-rate gyroscope is illustrated in Figure 1 and a block diagram of its electrical principles are as illustrated in Figure 2. The heart element of this gyroscope is a rectangular oscillating-beam. The oscillating-beam can be made of a constant elasticity alloy (Elinvar?) or it can be made of a crystalline material such as quartz or nissanli [6281 6808 9465]. On the four sides of the oscillating-beam are attached two pairs of piezoelectric transducers, and when a signal is applied to one pair of transducers (drive or feedback transducers), the beam produces a fundamental wave bending oscillation due to the reverse piezoelectric effect, i.e.,

$$X(t) = X_0 \sin \omega_c t \quad (1)$$

in which  $X_0$  is the maximum amplitude of the oscillation and  $\omega_c$  is the drive piezoelectric frequency.

The above described oscillation perpendicular to the direction of the drive plane produces a linear momentum  $m\vec{V}$  ( $\vec{V}$  is the particle's linear velocity, and  $m$  is the particle's mass). When the input angular-rate  $\vec{\omega}$  around the longitudinal axis, it produces inertia force in the readout plane perpendicular to the drive plane

$$\vec{F} = -2m(\vec{\omega} \times \vec{V}) \quad (2)$$

this force makes the pair of transducers in the readout plane also produce a mechanical oscillation. Because of the piezoelectric effect, the readout plane transducer produces an electrical signal output. The output piezoelectric value is determined by the amplitude of the mechanical oscillation. When the oscillating-beam, piezoelectric transducer and the drive piezoelectric are fixed, the size of the readout electrical signal is only related to the size of the input angular-rate  $\omega_z$ .

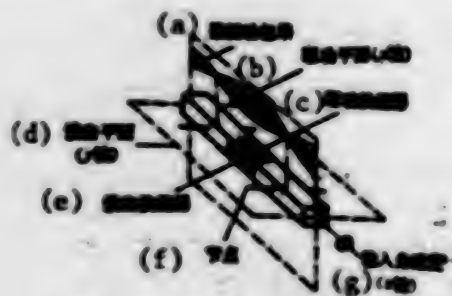


图1 振荡梁压电角速率陀螺的工作原理

Figure 1. Working principle of the oscillating-beam type piezoelectric angular-rate gyroscope

Key: a. beam oscillation envelope      e. readout transducer  
b. drive plane (x axis)                  f. node  
c. drive transducer                      g. input angular-rate (z axis)  
d. readout plane (y axis)

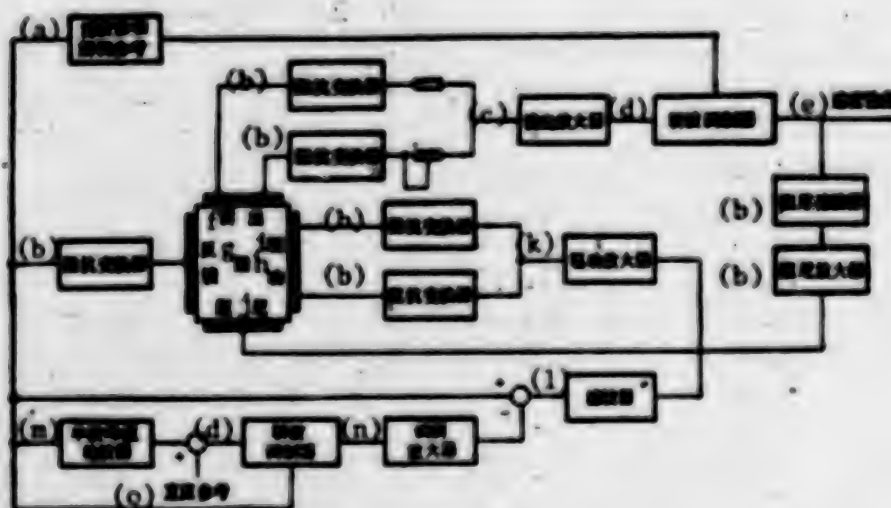


Figure 2 Electric principles of the oscillating-beam piezoelectric angular-rate gyroscope

Key: a. wave filter and demodulator reference      h. beam  
b. impedance transformer      i. drive  
c. readout amplifier              j. damping  
d. chopper modulator            k. drive amplifier  
e. velocity readout                l. filter  
f. readout                          m. semi-wave peak value checker  
g. feedback                        n. modulation amplifier  
o. direct current reference



The structure of the sensor component of the piezoelectric gyroscope is illustrated in Figure 3. The oscillating-beam dimensions are determined depending on use.

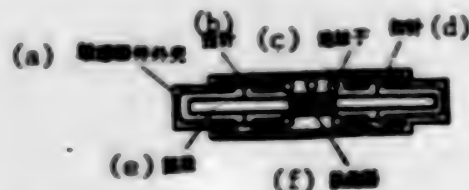


Figure 3. Sensitive component structure of piezoelectric gyroscope

Key: a. sensitive component shell  
 b. suspension pin  
 c. insulation  
 d. kourzen [2099 6859]  
 e. oscillating-beam  
 f. transducer

The piezoelectric gyroscope is a weak damped second order system, its natural frequency is close to the resonance frequency interval of the beam drive and the readout plane.

Combining the sensitive component and the corresponding circuitry together forms a complete gyroscope. A gyroscope with only one sensitive component installed is called a single axis gyroscope. A gyroscope with two sensitive components perpendicular to each other is called a dual axis gyroscope, and a gyroscope with three sensitive components perpendicular to each other is called a three-axis gyroscope.

The main features of the oscillating-beam piezoelectric angular-rate gyroscope are as follows:

Dynamic range:  $\pm 5$ – $\pm 7200^\circ/\text{s}$  (adjustable)  
 Sensitivity:  $< 0.001^\circ/\text{s}$   
 Proportional coefficient:  $0.5$ – $1000 \text{ mV}/^\circ/\text{s}$  (adjustable)  
 Linearity:  $< 1\%$  (full scale)  
 Natural frequency:  $50$ – $200 \text{ Hz}$   
 Damping ratio:  $0.2$ – $1.0$

The piezoelectric angular-rate gyroscope has broad applications in remote sensing and remote control systems. Since the piezoelectric angular-rate gyroscope can tolerate adverse environments, it is an indispensable remote indicator instrument in guided missile tests. At the same time, the piezoelectric angular-rate gyroscope has been used for guided missile target tracking platforms, aircraft stability augmentation systems, and shipboard radar stability servosystems.

## Twin Chip Type Piezoelectric Angular-rate Gyroscope

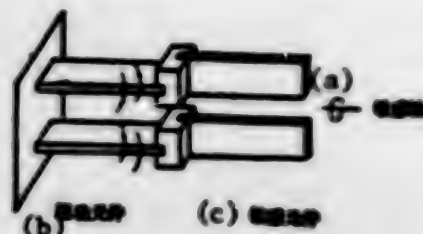


Figure 4 Piezoelectric twin-chip

Key: a. sensitive axis  
b. drive element  
c. sensitive element

The working principle of the twin-chip piezoelectric angular-rate gyroscope is illustrated in Figure 4. Two bending oscillation pattern type piezoelectric components are joined at a  $90^\circ$  angle. The piezoelectric component which is fixed to the base drives with its fundamental frequency and thus causes the sensitive component to produce an angular oscillation. When the sensitive axis is at zero angular-rate, the sensitive component does not produce bending and there is no output signal. When there is rotational speed, the Coriolis [0766 3044] force invokes a moment of force so that the sensitive component bends. The magnitude of the signal produced by the sensitive component is directly proportional to the angular-rate and phase is determined by the rotational direction.

The two arms of the tuning fork in Figure 4 are a pair of piezoelectric components. The feature of this structure is that the non-sensitive exterior oscillates and increases the rate.

Just as is the case with the oscillating-beam piezoelectric gyroscope, the twin chip-type piezoelectric gyroscope also has the advantages of long life, quick response, good linearity, delay can be overlooked, power consumption is small, and it is light in weight. There are also single-axis, double-axis, and triple-axis angular-rate models. Below we give the important features of the twin-crystal type piezoelectric angular-rate gyroscope:

Output: At zero angular-rate  $0V_{DC}$ , at full angular-rate  $\pm 10V_{DC}$ , maximum output current  $\pm 10mA$   
Sensitivity:  $\pm 30^\circ/s$ ,  $\pm 100^\circ/s$ ,  $\pm 300^\circ/s$  (full scale)  
Startup time: 1.0s  
System frequency: 280Hz  $\pm 10\%$   
Resolution ratio:  $0.04^\circ/s$  or 0.1% full scale  
Precision: 2% of reading  
Linearity: 0.1% full scale

Applications of the twin-chip type piezoelectric angular-rate gyroscope are the same as for the oscillating-beam type piezoelectric gyroscope. It should be explained that although the areas of application of these two types of piezoelectric gyroscopes are constantly expanding, it is the twin-chip type piezoelectric gyroscope that is being applied most widely.

# Tube-type Piezoelectric Angular-rate Gyroscope

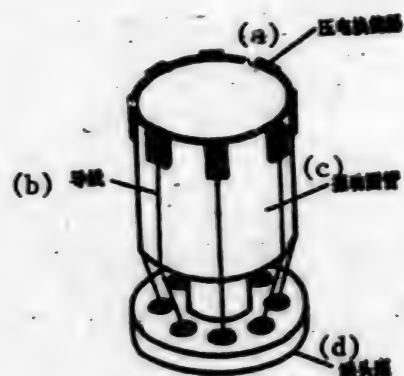


Figure 5 Oscillating-tube of tube-type piezoelectric gyroscope

Key: a. piezoelectric transducer  
b. guide wire  
c. oscillating tube  
d. terminal seat

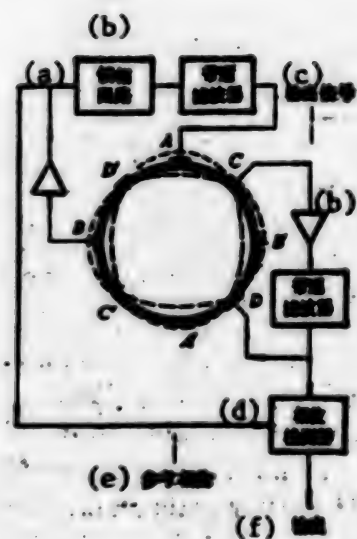


Figure 6 Principle of the tube-type piezoelectric gyroscope

Key: a. phase-locked loop  
b. bandpass filter  
c. output signal  
d. phase checker  
e. reference phase  
f. output

The tube-type piezoelectric angular-rate gyroscope is also a oscillation type gyroscope. Its oscillating tube and diagram of the electrical principles are given in Figures 5 and 6. The tube is a ceramic or metal cylinder. One end is sealed and installed on an axial framework and the other end vibrates freely. The bending oscillation of the cylinder wall is excited by the piezoelectric transducers around it. Figure 6 illustrates the bending oscillation of the tube by its fundamental wave and the overall wavelength of the two bending oscillations around the tube. This oscillation consists of standing-waves, the standing waves have four nodes and between the nodes there are internodes. Because the cylinder is symmetrical, any direction of standing-wave will vibrate in the same frequency. One pair of transducers A and A' drive Figure 6 so that their production has bending oscillation of the internodes. Using a feedback circuit which has a phase-locked loop, the drive signal frequency is stabilized at the bending resonance frequency of the cylinder. The phase-shift transducers B and B' which monitor the cylinder walls fetch the output signal, using this output signal provide the phase feedback to the phase-locked loop and thus maintain the phase-difference  $\pi/2$  between the phase shift and the drive piezoelectric.

When the cylinder doesn't move, the standing wave bearing doesn't move, the position of the wave nodes and internodes is maintained at a fixed point on the cylinder's circumference. When the cylinder rotates around its central axis, the standing wave of the bending oscillation is no longer relative to the cylinder remaining motionless and it is the position of the wave nodes and internodes that shift on the surface of the tube. By checking these angular shifts one can deduce the angular movement of the tube, and thus use the tube as a gyroscope to check the angular movement relative to the inertia coordinate system.

The simple method for obtaining angular-rate output is to install a piezoelectric transducer on the wave nodes on the surface of the tube to measure the radial component of the oscillation. When an angular-rate is input, the piezoelectric transducer senses the radial component of movement invoked by the Geshi force and the size of the Geshi force is in direct proportion with the angular-rate. Using a phase-sensitive rectifier or double-balanced modulator which uses the drive signal as a reference, the ac output signal is rectified and a dc signal which is proportional to the input angular rate is obtained.

The tube-type piezoelectric angular-rate gyroscope includes three parts: a drive oscillator and phase-locked loop which maintains the oscillation and a low noise amplifier which amplifies the electrical signal when the angular-rate is small and a phase-detector which converts alternating current into direct current. In practical installations, it is also necessary to control the response time of the sensitivity component to respond to rapidly changing angular-rates. Because mechanical damping makes the tube oscillation decay very slow, to obtain rapid response it is necessary to add external damping which can be implement through the piezoelectric transducers D and D' in Figure 6 which add negative feedback to the tube oscillation. The output



signal of transducers C and C' which are related to the input angular-rate are amplified and are applied to transducers D and D' with a definite phase, thus in D and D' produce a drive force which stops tube movement. Thus, the oscillation decay time can be regulated through gain in the feedback loop.

The technical features of the tube-type piezoelectric gyroscope are similar to those of the two piezoelectric gyroscopes described above.

The tube-type piezoelectric gyroscope is characterized by simple structure, ease of batch production, high reliability, and low cost. Therefore, this gyroscope has a future for broad application, and is especially suited to stability systems whose precision demands are not too high.

#### Piezoelectric Angular Acceleration Gyroscope

Adding a differentiator to the piezoelectric angular-rate gyroscope output terminal creates a piezo-electric angular acceleration gyroscope. The principles are illustrated in Figure 7.

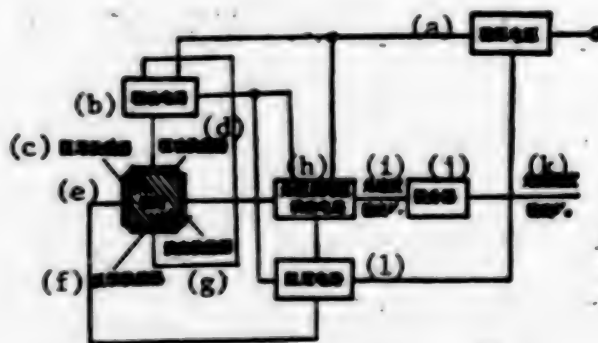


Figure 7 Principle of the piezoelectric angular acceleration gyroscope

Key: a. stable power supply  
b. drive circuit  
c. damping transducer  
d. drive transducer  
e. oscillating-beam  
f. feedback transducer  
g. readout transducer

h. angular-rate gyroscope readout circuit  
i. angular-rate output  $V_r$   
j. integrator  
k. angular acceleration output  $V$   
l. damping circuit

A special differentiator circuit can turn the oscillating-beam, twin-chip, and tube type piezoelectric angular-rate gyroscope series into piezoelectric angular acceleration gyroscopes. Because of the inherent nature of differentiation, whatever the type of piezoelectric angular-rate gyroscope, analog output of angular acceleration is stable and the zero position deviation is very small.

Because the piezoelectric angular acceleration gyroscope is a derived product of the piezoelectric angular-rate gyroscope, it has the inherent characteristics of the piezoelectric angular-rate gyroscope, i.e., high reliability, delay can be overlooked, good linearity, fast response, low power consumption, and light weight. Below we give the important technical features of the twin-chip type piezoelectric angular acceleration gyroscope:

Output: At zero angular acceleration  $0V_{DC}$ , at full scale angular acceleration  $\pm V_{DC}$ , maximum output current  $\pm 10mA$

Proportional coefficient:  $2^\circ/s/V$  (adjustable range  $1-40^\circ/s^2/V$ )

Startup time: 1.0s

System frequency:  $280Hz \pm 10\%$

Resolution ratio:  $0.04 /s^2$  (restricted by noise)

Precision: 2% of reading

Linearity: 0.1% full scale

The piezoelectric angular acceleration gyroscope is widely used in control systems for guided missiles, aircraft, ships, and tanks and it can provide the analog output of carrier angular-rate and angular acceleration.

#### Piezoelectric Stability Augmenter

The piezoelectric stability augmenter is also called a piezoelectric integrator. Its working principles are illustrated in Figure 8. It is a special integrator of the piezoelectric angular-rate gyroscope output terminal series described above. Below we give the important features of the piezoelectric stability augmenter:

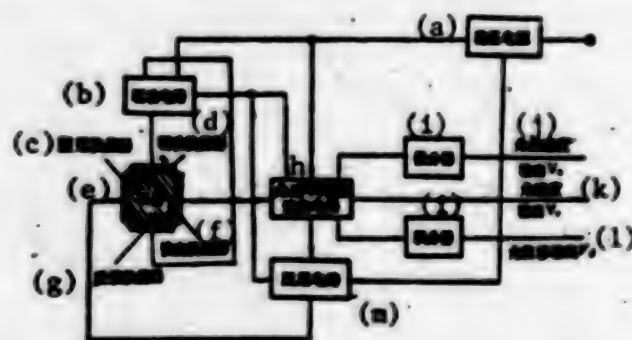


Figure 8 Principle of the piezoelectric stability augmenter

Key: a. stable power supply  
b. drive circuit  
c. damping transducer  
d. drive transducer  
e. oscillating-beam  
f. readout transducer  
g. feedback transducer

h. angular-rate gyroscope readout circuit  
i. integrator  
j. angular acceleration readout  $V_a$   
k. angular-rate readout  $V_r$   
l. angular shift readout  $V_d$   
m. damping circuit

Output: At zero angular-rate  $1.7V_{DC}$ , at full-scale displacement  $-4$  to  $+7/4V_{DC}$ ,  
maximum current  $\pm 10mA$   
Dynamic range:  $\pm 75^\circ/s$  rated full scale (adjustable)  
Startup time: 1.5s  
System frequency:  $280Hz \pm 10\%$   
Resolution ratio:  $0.04^\circ/s$  or  $0.1\%$  full scale  
Linearity:  $0.1\%$  full scale

The piezoelectric stability augmenter can be used as a stability augmenter in guided missiles, aircraft and marine control systems.

#### Angled Velocity Output Piezoelectric Clinometer

The angled velocity output piezoelectric clinometer can accurately sense rotation around a horizontal axis. It not only can output an analog voltage proportional to the rotational position, but also can output an analog voltage proportional to the rotational angular-rate.

The key parts of the piezoelectric clinometer is a precision pendulum and an angular-rate gyroscope. The angular-rate output signal integrator receives the rotational position output signal, the signal is compared with the pendulum's output signal, and the error signal obtain is uses as bias feedback to the angular-rate gyroscope.

The piezoelectric clinometer has the features of piezoelectric angular-rate gyroscope and pendulum, but its precision is far superior to the precision obtained independently by the pendulum and the piezoelectric angular-rate gyroscope. It has the advantages of rapid response, not being sensitive to acceleration, high resolution ratio, and low power consumption. Below we give the important technical features of a single-axis piezoelectric clinometer:

Output: angle position: at zero angle position  $0V_{DC}$ ,  $5^\circ/s/V$ , maximum angle position  $\pm 45^\circ$ ; angular-rate: at zero angular-rate  $0V_{DC}$ ,  $3^\circ/s/V$ ; adjustable range:  $1^\circ$  to  $30^\circ/s/V$ , full scale  $\pm 10V$ ; self-selected output: angled velocity.

Precision:  $\pm 1^\circ$  position,  $1\%$  of readout angular velocity

Correction axis:  $\pm 1\%$

Frequency response:  $0$  to  $55Hz$ , position and angular-rate

8226

CSO: 4008/1025

APPLIED SCIENCES

METHOD OF USING CTC TO MICROCOMPUTERIZE DIGITAL INSTRUMENTS

Beijing DIANZI KEXUE JISHU [ELECTRONIC SCIENCE AND TECHNOLOGY] in Chinese  
Vol 15, No 1, 10 Jan 85 pp 5-6

[Article by Wu Naiyou [0702 0035 0327]: "Method of Using CTC To Microcomputerize Digital Instruments"]

[Text] This article introduces a method of borrowing the Z80 single-board computer CTC to microcomputerize digital instruments. While preserving all the functions of the single-board computer, this method fully exploits software potential, simplifies hardware design and is characterized by high precision, high reliability, low cost, and ease of extension.

Basic Method

When measuring a frequency, the measured frequency  $f$  is determined by the time the main gate is opened and the reading of the counter in this time  $N$ . Their relationship is  $f = N/t$ . To improve measurement precision, the measurement method of combining multiple cycle average value and deducting low numbers was adopted. In hardware design, the expanding of the CTC was avoided by using the CTC1-CTC3 channels which were originally occupied by the single-board computer monitor program. The circuit is as illustrated in Figure 1. After shaping, the measured signal is sent by switch control to CTC1 counting and at the same time, each time CTC0 requests an interrupt through benchmark time  $T$ , 1 is added to the timing value  $S$  (content of the DE register dui [1417]). When CTC1 has counted to the Number  $N$ , an interrupt is requested, the timing value  $S$  is sent to the data region, and after processing according to  $f = N/T \cdot S$ , finds the tested frequency. Software design includes a main program and three interrupt service programs. It is written in assembly language. The flow chart is illustrated in Figures 2-5.

Because of borrowing three CTC channels and at the same time using three screenable interrupts, it is necessary to pay attention to the distinction between the CTC channels and their function in the monitor program. Otherwise, when debugging a program there may be failures due to changes in CTC setup in the keyboard operation invoked in a user program or due to the CTC setup in the user program using corresponding key functions.



## Frequency Measurement Program Design

Frequency measurement should occupy the two channels CTC0 and CTC1. Since CTC1 is occupied in the monitor program by DUMP, the tape dump command key, working in timing mode 4800Hz code "1" and 2400Hz code "0" audio frequency signals are used to produce a 40 second complete "1" guide. As long as this key is not used when executing a user program no wrong actions will occur. To ensure timing accuracy, the CTC0 timing interrupt and the "interrupt nest" formed with CTC1 are used. The CTC0 timing interrupt is used because its rank is highest among the CTC interrupt priority keys, and its timing precision cannot be influenced by registering interrupt responses of other channels. To make the timing and the counting synchronous, program design uses the CTC1 full count N number, ZC/T01 output positive pulse starts CTC0 timing, thus the first measurement cycle actually is a "null operation."

To ensure measurement accuracy, program design should be selected appropriately based on the inherent relationship between the three elements  $f$ ,  $N$ , and  $S$  in the formula  $f = N/\tau \cdot S$ . First of all, the benchmark time value  $\tau$  should be selected,  $\tau = t \cdot P \cdot T_c$ , in which  $t$  is the system clock cycle, generally taken as  $0.5 \mu s$ ;  $P$  is the reference coefficient, determined at 16 or 256 by the control word  $D_5$ ;  $T_c$  is the time constant fixed by the programming. Clearly, the smaller the value of  $\tau$ , the higher the measurement precision. However, it has a limited value, i.e., it must be greater than the time required by the CTC0 interrupt service program, otherwise the CTC0 interrupt service program cannot carry out the operation of making the timing element DE register add 1 and will cause an error in the timing value  $S$ . Thus, however simplified the CTC0 interrupt service program, compressing execution time will be beneficial for improving measurement precision. Selection of the  $N$  value should be based on consideration of the range of the measured frequency: on the one hand it cannot make the timing value  $S$  too big and go beyond the two byte range, for example, when measuring a low number, the value of  $N$  will be fetched too large; on the other hand, it cannot make the timing value  $S$  too small, otherwise the intermediate results of division operations in data processing programs will overflow, for example measuring the measured signal, the value of  $N$  will be fetched too small. Both of these will produce wrong results. The number of measurement times  $M$  is selected primarily on the basis of the demand for measurement speed and repetitive precision.

## Sample Holding Control Program Design

Sample holding control occupies the two channels CTC2 and CTC3 and is used for producing delay times greater than 33ms to ensure the stability of the measured signal. Because the maximum delay time of each CTC channel is about 33ms ( $T = t \cdot P \cdot T_c = 0.5 \times 256 \times 256$ ) and because of the limitations of the enclosure the CTC3 has not yet extracted the ZC/T0 output terminal, program design uses CTC2 to operate in inhibited interrupt and automatic timing mode. CTC3 works in permitted interrupt, external triggered counting mode, to send the CTC2's ZC/T02 output to CTC3's CLK/TRG3 terminal as counting pulse and producing the necessary delay time control signal.

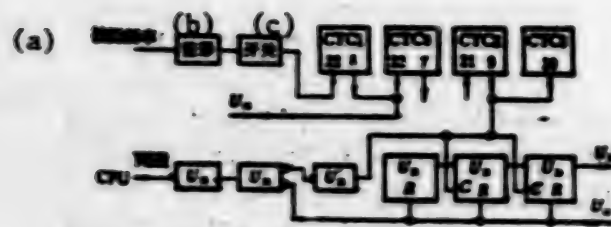


Figure 1

Key: a. measured frequency  
b. shaping  
c. switch

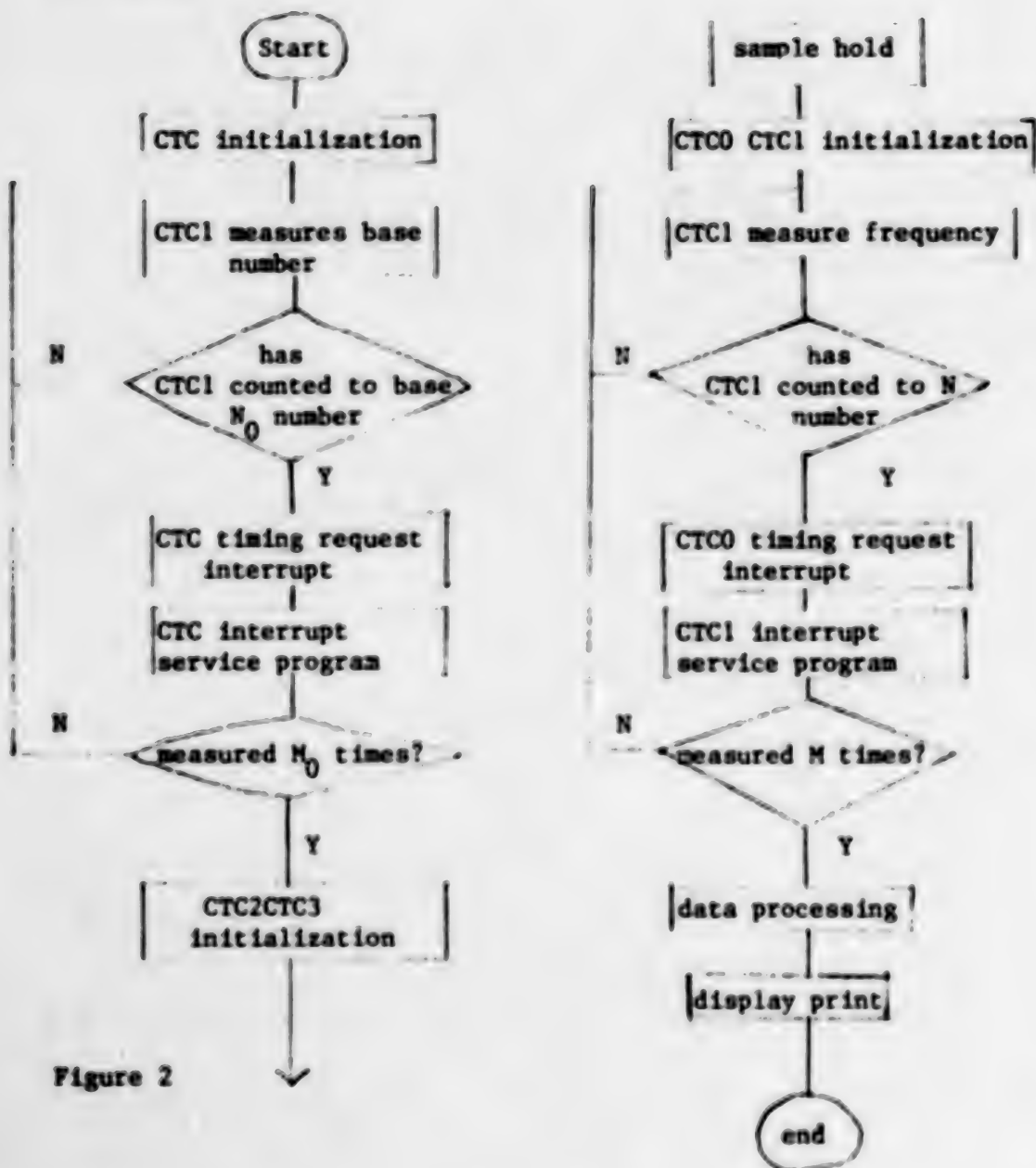


Figure 2

maintain present  
field

timing element  
DE adds 1

restore present  
field

open interrupt  
return

open interrupt

timing element  
contents sent  
to data area

revise data  
area address

timing element  
cleared

number of  
measurement  
times reduced  
by 1

return

replace stack  
contents

turn off  
stepping motor

return

Figure 3

Figure 4

Figure 5

Because the tape input CASS, LOAD key occupies CTC3 in the monitor program, it works in timing mode, and is used to produce a 1.6 ms or 3.2ms timing interrupt. Like the CTC1, as long as it is executing a user program it does use the CASS LOAD key.

In the monitor program, CTC2 uses the single step SS, monitor MON, and EPROM program keys in common. When used for the single step key, operations are in timing mode, and after 88 $\mu$ s, its ZC/T02 pulse is used as a non-screen interrupt request to the CPU. When used for the monitor key, operations are in counting mode and each time the MON key is pressed it also uses the ZC/T02 pulse as a non-screen interrupt request. Quite the opposite of the previous two, when used for programming, operations are in timing mode and used to produce a 26ms timing pulse ZC/T02, but at this time a non-screen interrupt request is not produced. From an analysis of circuits related to CTC in Figure 1 it can be discovered that EPROM programming from U<sub>11</sub> permits a "1" level, so that the NOR gate U<sub>34</sub> is locked and the ZC/T02 pulse has no way to get to the CPU's NMI terminal through U<sub>34</sub> and U<sub>33</sub>. From this it can be seen that when borrowing CTC2, if U<sub>34</sub> is not locked, when executing

a user program there can be an error by automatically jumping into the monitor display modification program DISUP. To avoid the above error, we can reference the program for controlling EPROM programming (in the example of TPBUG):

Address	Tag	Source code	Notes
05E4	CCS12A	LD A, 25H;	CTC2 used for timing
05E6		OUT(CTC2),A	
05E8		LD A, OCBH	OCBH = 203D
05EA		OUT(CTC2),A	send constant
05EC		LD A, 80H;	clear display
05EE		OUT(DIGLH),A	set EPROM edit permit pulse to 1

rewritten to the timing operation mode desired, and finally the two statements are determined by hardware connects and cannot be changed.

We used the above described method for a topic which used a stepping motor drive mechanical sampling device, using the fixed characteristics of the stepping motor to eliminate the mechanical intervals and maintain the stability of the measured signal and thus replace the sample holder, with good results. As long as the technique of borrowing CTC2 is mastered, the demands of delay control in different cases can be met.

#### Main Program Design

The main program is made up of four parts: initialization, measuring base number, measuring signal, and data processing. When measuring the base number, two interrupts are used on channels CTC0 and CTC1, when the measurement is finished, the channels are reset by software. When measuring the signal, three interrupts are used on channels CTC0, CTC1, and CTC3 and when the main program measuring is finished, channels CTC0 and CTC1 are turned off and it waits until after the interrupt service program on channel CTC3 has been executed, then the main program begins to turn to data processing. Because multiple channel interrupts are used at the same time, the channels not being used for the time being must be turned off. There is an interconnection between the interrupt vectors and they cannot be set voluntarily. No matter which channel's interrupt vector is set first, all should be sent through channel 0, and the lower four bits of its interrupt vector must be 0 or 8. In the initialization program it is necessary to pay careful attention to these problems.

The data processing program first finds the average of the corresponding timing values of the base number and the tested signal, computes the base number  $f_0$  and measured value  $f$ , then finds their difference  $(f - f_0)$ , i.e., the true measurement result, and outputs it on a TP801P microprinter.



The main programs focuses on borrowing CTC and can only measure single channel frequency signals, but under the control of a parallel interface P10, it can perform multi-channel measurement and other control functions. Because CTC1 operates in counting mode, a system clock ascent after the effective edge of the measured signal input at the CLK/TRG1 terminal causes the counter to decrement by 1 and the measured signal and the system clock are synchronous. Thus, for the measured signal it is necessary to have a minimum pulse width limitation and its clock cycle must not be smaller than three times the system clock. Thus, for the Z80-CTC, the measured signal should be a rectangular wave of an amplitude compatible with TTL, the larger the occupied space ratio the better and the maximum frequency must not exceed 1MHz.

In view of the fact that there are so many types of Z-80 single board computers, the monitor programs used are also different, and in terms of the CTC itself, there are the Z80-CTC, Z-80A-CTC and Z80B-CTC, but the hardware connections are similar. Thus, apart from the necessary shaping and switching circuits, as long as two leads are added to the CTC, it can carry out frequency measurement and preserve all single-board computer functions.

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CSO: 4008/1025

APPLIED SCIENCES

DIGITAL PHASE METER USING CMOS-LED INTRODUCED

Beijing DIANZI KEXUE JISHU [ELECTRONIC SCIENCE AND TECHNOLOGY] in Chinese  
Vol 15, No 1, 10 Jan 85 pp 25, 28

[Article by Tan Benzhi [6223 2609 2535]: "CMOS-LED Digital Phase Meter"]

[Text] The structure of the CMOS-LED digital phase meter introduced in this paper is simple, its performance is stable, it is suitable for phase testing of low frequency signals, there are no strict demands on the wave form of the tested signal, sine waves, triangular waves, and square waves can be measured, and the tested signal can be in the 0.2V - 300V range. In addition to carrying out phase testing of small signals, through attenuation switch conversion, it can also be used to measure the phase difference of threephase service power supplies, is much easier to observe than a phase sequencer, and measurement error is  $\pm 1\%$ .

A block diagram of the principles is given in Figure 2. Two test signals of the same frequency  $f_0$  and  $f_0'$  are input for amplification limiting in channels A and B, triangular waves and sine waves are converted into square waves, then after shaping are sent to the pulse formation circuit, two phase pulses are obtained to control phase checking bistable reversal. The A and B channel circuits are completely homogenous, and use a CMOS C033 for limiting amplification and shaping. The A channel square wave  $F_0$  is sent to the phaselocked frequency doubler PLL and the D flip-flop. The phaselocked frequency doubler multiplies  $f_0$  360-fold and maintains the initial phase unchanged. The  $360f_0$  is controlled by AND gate  $A_1$ . When  $\bar{A}_1$  is 0, i.e. CP terminal is 0, the counting begins, and when  $\bar{A}_1$  is 1, the counting stops.

Supposing the phase difference of  $f_0$  and  $f_0'$  is  $90^\circ$ , the phase checking bistable output terminal pulse width  $\bar{Q}_1 = 1/(4f_0)$ , the counting pulse  $f_x = T_1 \times 360f_0 = 360f_0/(4f_0) = 90^\circ$ . The counting conditions must be  $Q_1 = 1$ ,  $Q_2^x = 1$ , then  $\bar{A}_1 = 0$ . When  $Q_2 = 0$ ,  $\bar{A}_1 = 1$ , the counting stops and at the same time it makes  $\bar{A}_2 = 1$ , triggers monostable 1, and makes  $\bar{Q}_3 = 0$  (transient state), i.e., LE terminal changes from 1 to 0 making the register and the counter synchronous, the number in the counter is sent to the register thus displays the number of pulses of the tested signal  $f_0$ . When the monostable 1 is restored,  $Q_3$  changes from 0 to 1, the register is in a storage state, the meter maintains the reading number and at the same time triggers

monostable 2 (when stable,  $Q_4 = 0$ ) so that  $Q_4$  is 1, i.e., R terminal changes from 0 to 1 so that the counter is again 0. When the control signal of the next cycle is again added to the CP terminal, the counter counts again, looping like this automatically. As long as the phase difference of the tested signals  $f_0$  and  $f_0'$  does not change, the display is stable.

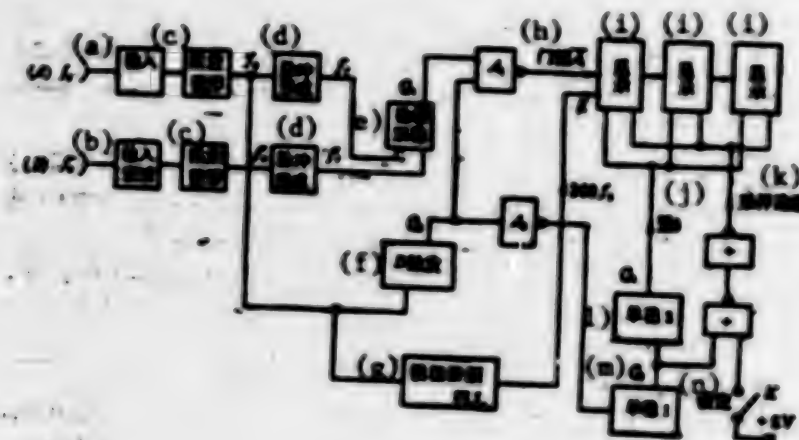


Figure 1

- Key: a. input  
b. input attenuation  
c. limiting amplification shaping  
d. pulse formation  
e. phase checking bistable  
f. D flip-flop  
g. phase-locked frequency doubling PLL  
h. gate control  $A_1$   
i. display  
j. set to 0  
k. sampling channel select  
l. monostable 2  
m. monostable 1  
n. latch





11 July 1985

## APPLIED SCIENCES

## LATCH-UP EFFECT IN CMOS CIRCUIT DESCRIBED

Beijing DIANZI KEXUE JISHU [ELECTRONIC SCIENCE AND TECHNOLOGY] in Chinese  
Vol 15, No 1, 10 Jan 85 pp 2-4

[Article by Zhang Lichun [1728 0448 2504], Shen Timing [3088 1879 494],  
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Department, Beijing University and Feng Chuguang [7458 0443 0342] and  
Zhang Ziang [1728 5638], Beijing Semiconductor Component No 5 Plant: "Latch-up  
Effect in CMOS Circuits"]

[Text] The latch-up effect was first discovered in a small-scale bipolar integrated circuit. As long as there are parasitic four-layer PNP structures, under certain conditions, the latch-up effect can occur. Since bulk CMOS circuits are of four-layer structure, the latch-up effect is a failure mode which often occurs in them. With the improvement of integration and the reduction in component dimensions, the latch-up effect can become increasingly serious. Therefore, how to reduce or eliminate the latch-up effect and improve the reliability of CMOS circuits is a subject which has been getting more and more attention.

This article discusses the latch-up phenomenon in CMOS circuits, analyzes the conditions which product it, and on the basis of our work, proposes preventative measures in design, industrial technology and use.

## The Latch-up Phenomenon

Latch-up exists in bulk CMOS circuits, but here we will analyze it in terms of only one of the basic elements of the CMOS circuit--the inverter. Figure 1 is a circuit diagram of the CMOS inverter, Figure 2 is a technical cross-section. From Figure 2 it can be seen that in the CMOS circuit there are longitudinal parasitic NPN transistors and lateral parasitic PNP transistors which are similar to four-layer silicon controlled structures. Figure 3 is a diagram of an equivalent inverter parasitic silicon controlled circuit. With external noise, the inverter can enter a latch-up state. From Figure 3 it can be seen that when a positive pulse noise voltage (higher than power source voltage  $V_{DD}$ ) is added to the output terminal, first of all it can make the  $T_3$  transistor positively biased and at this time the noise current  $I_N$  can flow through  $R_W$  through transistor  $T_3$  and produce an additional voltage



Figure 1

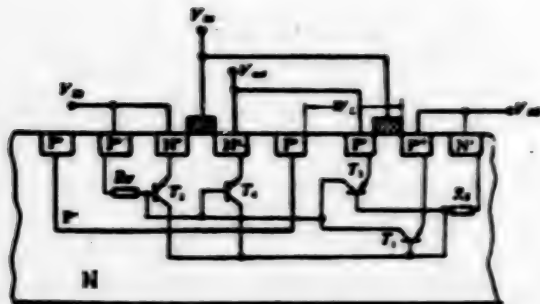


Figure 2

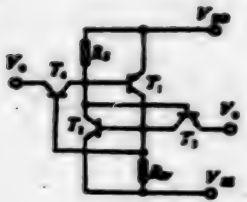


Figure 3

drop  $a_3 I_N R_S$ . When  $a_3 I_N R_S > V_{be2}$  (voltage is conducted between the base and the emitter of transistor  $T_2$ ), transistor  $T_2$  begins conducting forward. At this time electricity will be flowing from  $V_{DD}$  through  $R_S$  and transistor  $T_2$  to  $V_{SS}$ , the voltage drop across the resistance  $R_S$  will be  $I_{C2} R_S = \beta_2 a_3 I_N R_S$ . In this way, transistor  $T_2$  conducting also provides base current  $I_{b1} = I_{C2} / \beta_1$  for transistor  $T_1$ , and when  $I_{C2} R_S \geq V_{be1}$ , transistor  $T_1$  also begins to conduct positively. It is very clear that  $T_1$  conduction also in turn is the current  $I_{b2}$  supplied to transistor  $T_2$ . When the condition  $I_{C1} = I_{b2}$  is satisfied, i.e.,  $\beta_1 \beta_2 a_3 I_N = a_3 I_N$ ,

$$\beta_1 \beta_2 = 1$$

in which,  $\beta_1$  is the current amplification coefficient of transistor  $T_1$ 's common emitter,  $\beta_2$  is the current amplification coefficient of transistor  $T_2$ 's common emitter, and  $a_3$  is the amplification coefficient of transistor  $T_3$ 's common emitter.

As it happens, they are structured in a regenerative fashion so that  $T_1$  and  $T_2$  conduct completely. At this time, the voltage between terminals  $V_{DD}$  and  $V_{SS}$  drops sharply to conduction value  $V_{DE(PNP)} + V_{CE(NPN)}$  which is just like being latched. Even after the external noise pulse disappears, an abnormal current still exists between power source  $V_{DD}$  and  $V_{SS}$ , which is sometimes as high as several hundred milliamps. This is the latch-up effect, also called the controllable silicon effect. When this current exceeds the ultimate permissible value of the circuit, the circuit will be burned out. Figure 4 gives the I-V curve produced in latch-up.



Figure 4

From the above analysis it can be seen that the conditions that produce latching are: 1. the product of the current amplification coefficients of the parasitic transistors  $T_1$  and  $T_2$   $\beta_1 \cdot \beta_2 \leq 1$ , which is also the conditions in which the circuit produces regeneration; 2. the horizontal transistor  $T_1$  and the longitudinal transistor  $T_2$  are both forward biased, and have injection; 3. the current supplied by the power supply in the circuit exceeds the holding current  $I_{HOLD}$  after  $T_1$  and  $T_2$  conduction or use voltage exceeds the critical voltage  $V_{crit}$ .

#### Measures For Preventing Latch-up Effect

To prevent latch-up it is necessary to destroy the conditions that produce it and this requires measures in design and technology. These measures include:

1. Reducing The Current Amplification Coefficient Of The Two Parasitic Transistors So That Their Product  $\beta_{PNP} \cdot \beta_{NPN} < 1$ .

We know that the current amplification of bipolar transistors is mainly related to the emitter junction injection efficiency, base area width and shaozi [1421 1311] life. That is, the lower the doped thickness of the transistor's emitter region, the higher the doped thickness of the base region, the larger the width of the base region, and the shorter the life of the shaozi, the smaller the current amplification coefficient of the transistor. To make the product of current amplification coefficients of the two parasitic transistors  $\beta_{PNP} \cdot \beta_{NPN} < 1$ ,  $\beta_{PNP}$  and  $\beta_{NPN}$  should be reduced as much as possible. Considering domain design and technological factors overall, in silicon gate CMOS circuits we adopted such measures as ensuring a certain depth of P traps and appropriately enlarging the interval of P channel MOS transistor active areas from P trap boundaries which can make  $\beta_{PNP} \cdot \beta_{NPN}$  much less than 1. Some typical CMOS circuit test data is displayed in Table 1.

Table 1

	$\beta_{PNP}$	$\beta_{NPN}$	$\beta_{PNP} \cdot \beta_{NPN}$
CC4069	0.01 - 0.02	2 - 2.5	0.02 - 0.05
CC4011	0.05 - 0.06	3.5 - 4	0.18 - 0.24
CC4013	0.01 - 0.02	0.7 - 5	0.01 - 0.04

From current tests and use it can be seen that these CMOS circuits do not have recurring latch failure and have obtained good results.

## 2. Reducing Resistance $R_S$ and $R_W$ Values

From Figure 3 and the preceding analysis it can be seen that another condition which produces latching is that the bipolar transistor emitter junction must be in forward biased injection. Thus reducing the substrate resistance  $R_S$  and the P trap resistance  $R_W$  has important significance.

(1) Design. From Figure 2 it can be seen that in domain design that substrate N+ contact hole connects  $V_{DD}$  and P+ contact hole in P trap contact resistance and the position of the contact hole will directly affect the resistance values  $R_S$  and  $R_W$ . That is, the further the substrate N+ contact hole is from the P trap, and the further the P+ contact hole in P trap is from the active area of the N-channel MOS transistor, the greater the resistance  $R_S$  and  $R_W$  and the easier it will be for the latch-up effect to occur. Thus, rational design of circuit layout, especially the output stage, rationally opening the contact hole of the power supply  $V_{DD}$  and the ground  $V_{SS}$  (based on the principle of reducing resistance), and extending the  $V_{DD}$  and  $V_{SS}$  aluminum contact everywhere is very beneficial for preventing the latch-up effect.

(2) Technology. Since the third condition which produces latching can be known, if the current supplied in the circuit by the power supply is less than its holding current  $I_H$ , latch-up will not occur. The holding current  $I_H$  is

$$I_H = \frac{I_{RW}\beta_{PNP}(\beta_{NPN}+1) + I_{RS}\beta_{NPN}(\beta_{PNP}+1)}{\beta_{PNP} \cdot \beta_{NPN} - 1}$$

in which  $I_{RW}$  is the lateral current through P trap resistance  $R_W$ ,  $I_{RS}$  is the lateral current through substrate resistance  $R_S$ .

To increase  $I_H$ , it is necessary to increase  $I_{RW}$  and  $I_{RS}$  and reduce  $\beta_{PNP}$  and  $\beta_{NPN}$ , that is, it is necessary to reduce  $\beta_{PNP}$ ,  $\beta_{NPN}$ ,  $R_W$ , and  $R_S$ . In a typical P trap CMOS circuit, P trap resistance  $R_W$  reduction should be subject to a certain limitation, thus reducing  $R_S$  is a more effective method.

In industrial technology, using an epitaxial structure CMOS circuit<sup>[2]</sup> can greatly reduce the substrate resistance  $R_S$ , thus dropping the voltage applied on  $R_S$  to the minimum value, so it is not easy to make the parasitic transistor emitter junction forward biased which improves the reliability of the circuit. According to reports<sup>[3]</sup>, using epitaxial structure not only can improve the degree of integration, but also the holding current can be improved up to seven-fold.

We made our initial test silicon chips with epitaxial chip and mono-crystal chip substrates. The specific method of preparing the buried layer epitaxial chip was: We carried out high temperature antimony diffusion doping



on a (100)N Type silicon chip, the prediffusion sheet resistance of the antimony  $R_a$  was  $20-25 \Omega / \square$ , then we carried out antimony diffusion at a temperature of  $1210^\circ\text{C}$  for up to 20 hours and after diffusion, the sheet resistance was  $20 \Omega / \square$ . Finally we again grew an epitaxial layer 12 - 14 thick with a resistance of approximately 3 ohms/cm. We used the same technology (the same mask) for both types of silicon chips and compared them with silicon gate CMOS circuit C036<sup>[4]</sup>. Typical results are given in Table 2.

Table 2

	$\beta_{\text{NPN}}$	$\beta_{\text{PNP}}$	$I_H$	$V_H^*$
epitaxial chip	5-6	0.02	20mA	16-18V
monocrystal chip	7	0.02	6-8mA	16V

\* $V_H$  is the holding voltage

From Table 2 it can be seen that using epitaxial structure,  $\beta_{\text{PNP}}$  and  $\beta_{\text{NPN}}$  do not change greatly, but  $I_H$  is improved by almost 2-3-fold. This is because the epitaxial structure greatly reduces the substrate resistance  $R_s$ .

### 3. Using Pseudo-collector Structures In The Circuit



Figure 5

As illustrated in Figure 5, in the I/O part where it is easy for a latch to be produced, a P-layer simultaneously formed with the P trap is installed in the base region of the lateral parasitic PNP transistor and creates an ohm contact which makes it receive  $V_{SS}$ . It can be seen that as far as the lateral PNP transistor is concerned introducing the P-layer adds a collector which is even closer and we call this the pseudo-collector. Because of the introduction of the P-layer, a major portion of the lateral PNP transistor's emitter injection hole is absorbed by the P-layer and thus the current amplification coefficient of the lateral PNP transistor is greatly reduced. Thus it can effectively prevent the latch-up effect. According to reports,  $I_H$  of CMOS circuits using this structure can reach more than 450mA. However, its shortcoming is that the chip area is large.

### Input Protection Structure

In the CMOS circuit which was actually developed, the input terminals all have protection circuits. The latch-up effect can also be produced due

to the noise interference of the input terminal. We will not go into an analysis of this process here. Suffice it to say that, how the CMOS circuit input terminal protection is done, plays an obvious role in preventing the occurrence of latch-up. We used an input protection circuit as illustrated in Figure 6. In this circuit, the numerical value of the input protection resistance  $R$  should be chosen properly, generally within the range of  $500\Omega - 1k\Omega$ . For circuits with high speed demands, a circuit as illustrated in Figure 7 is adopted. This circuit not only can reduce speed loss, but also can protect the limiting function played by the diode and suppress latch-up failure caused by the input terminal.

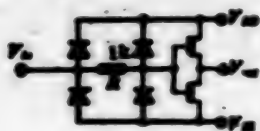


Figure 6

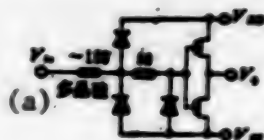


Figure 7

Key: a. multicrystal gate

#### 5. Improving Circuit Breakdown Characteristics Adding A Clamp Protection Structure Between The Power Supply And The Ground

The diode  $D$  in Figure 1 performs this function. From Figure 4 it can be seen that before the latch occurs, the I-V curve first goes through a breakdown  $BV$ , then after going through  $V_{crit}$  it produces a latch-up, thus improving the diode's breakdown voltage  $BV_{crit}$  will help prevent the production of a latch-up.

In the actual circuit, the working voltage is much lower than the breakdown voltage  $BV$ , thus in domain design, clamp protection measures can be added so that the voltage added to the circuit will be far below the breakdown voltage  $BV$ .

In addition, at an early stage in the technology, we adopted a gold doping and neutron irradiation method to reduce shaozi life, and thus reduce the current amplification coefficient of the parasitic transistor. However, this is rarely adopted now.

#### Paying Attention to Preventing Latch-up In Use

In addition adopting measures in design and industrial technology to prevent the latch-up, in use, one should also strive to avoid latch-up. For example, one should:

1. First connect the power supply  $V_{DD}$ , then connect the input signal  $V_{in}$ ; first break off the input signal, then turn off the power supply.
2. The input signal  $V_{in}$  should satisfy  $V_{DD} + 0.5V \geq V_{in} \geq V_{SS} - 0.5V$ .

3. Input terminals not in use should not be in suspension, but should be connected to  $V_{DD}$  or  $V_{SS}$ .

We have only carried out preliminary researches on the latch-up effect in CMOS circuits. Some of the measures to prevent latch-up failure have been used in the silicon gate CMOS circuits produced by the Beijing Semiconductor No 5 Plant and circuit testing and user use show that the CMOS circuit reliability is excellent. We are continuing to carry out this research work further.

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CSO: 4008/1025

APPLIED SCIENCES

DUAL-SYSTEM OF 1000-SERIES COMPUTERS PASSES EVALUATION IN KUNMING

Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 11, 8 Jun 84  
p 1

[Article: "1000-Series High Grade Rigidized Dual-System Comes Out"]

A vehicle mounted rigidized dual-system in the 1000 series high grade computer line--the 1155 dual system--recently passed evaluation in Kunming.

This dual-system was jointly developed by the Tianjin Municipal Computer Institute and the Yunnan Electronic Equipment Plant, and relevant peripheral production plants configured the rigidized peripherals for the system.

The system is made up of two 1155 computers, each of which has an interprocessor buffer (IPB), a multichannel adapter (MCA) and an input/output bus controller (I/O BC) forming a dual-system which can share disk drives in duplex, dual processing, and dual computer forms, and carry out trouble monitoring and automatic replacement between the two computers. This system is a clear improvement over the single computer system in terms of real-time functions, processing efficiency, and reliability.

The IPB and MCA components of the system are compatible with corresponding software of the U.S. DG Company, thus this system can be operated with the support of the NRDOS real-time disk operating system, and this is a first for the 1000-series computers. The role of the I/O BC is so that the two system can share peripheral resources.

Before the evaluation, function assessments and long distance road tests were carried out on this system, and the results in all norms conformed to the demands of the general plan. Representatives participating in the evaluation meeting expressed satisfaction with the system's rigidized packaging inter-connection technology and felt that it was rational in design, had good maintainability, and was suited to the demands of vehicle mounting. The disk drives from the Shanghai Electronic Equipment and Materials Plant made a deep impression on the representatives in this regard.

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APPLIED SCIENCES

GF20/11A CHINESE CHARACTER MICROPROCESSOR SYSTEM DESIGN FINALIZED

Beijing JISUANJI SHILIE [CHINA COMPUTERWORLD] in Chinese No 11, 8 Jun 84  
p 7

[Article: "Good Progress in Making the Chinese Character Microcomputer Practical; GF20/11A Chinese Character Microcomputer System Design Finalized"]

[Text] The GF20/11A Chinese character microcomputer system jointly developed by the Computer Institute of the Chinese Academy of Sciences, Plant No 524 of the Ministry of Posts and Telecommunications, the Guangdong Shaoguan Wireless Radio Plant and the Guangdong Institute of Electronics recently passed design finalization in Guangzhou with the support of the Guangdong Province Science Commission.

The basic configuration of this microcomputer system is: hardware: Z80Z CPU, 512KB dynamic RAM, 2 8-inch double-sided double-density disk drives, 4 parallel and 1 serial addressable I/O interfaces, 1 dedicated serial communications interface, 1 CRT with Chinese, English, digital and graphics capabilities, and an ASCII keyboard. Inside there is: 512 KB dynamic RAM (expandable to 1 MB), 8K ROM, 16K display memory, IEEE796 bus. The software is rich including BASIC, COBAL, FORTRAN, and PASCAL, the COBMS Chinese character data file management system, CDBASE Chinese character relational database, telephone network communications program, telegraph network communications program, Chinese character screen editor program, Chinese character dictionary generator program, Chinese character character library set up and maintenance program, and several encoding schemes. When the software system was designed, consideration was given to using the popular 8-bit CP/M operating system which could be completely compatible with CP/M and other software it supported, as well as the special features of processing Chinese characters.

This is a very powerful general purpose system which can adapt to a variety of Chinese character input coding methods and can also carry out file transmission over the telephone and telegraph circuits. The representatives who participated in the meeting felt that among important domestic Chinese character microcomputer series, this system was one of the most practical. Through testing by users, this model has proven

to be stable, reliable, can function as an independent Chinese character processing system as well as general purpose computer or smart terminal for other computers. Its appearance is an important advance on the road of making China's Chinese character computers practical.

The Shaoguan Wireless Radio Plant will produce this system.

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APPLIED SCIENCES

WORK ON CHINESE CHARACTER RECOGNITION ACHIEVES PROGRESS

Beijing JISUANJI SHLJIE [CHINA COMPUTERWORLD] in Chinese No 11, 8 Jun 84  
p 6

[Article: "China's Work on Chinese Character Recognition Achieves Progress"]

[Text] Reporters from this newspaper learned from the National Automated Recognition Conference which recently concluded that in recent years China has made great progress in Chinese character recognition research work and results of an advanced level have emerged, so the gap with international levels in terms of basic theory and implementation methods in automated Chinese character recognition is not great.

This conference was jointly convened by the Basic Theory and Specialized Equipment Committees of the Chinese Language Information Research Society of China. Nearly 100 representatives from 16 provinces, municipalities and autonomous regions attended the meeting. Twenty-four papers were read at the meeting including an introduction to automated recognition, the results of character recognition, advances in most recent development of Chinese character recognition, sound controlled telephone, phonetic recognition and comprehension system, and techniques for recognizing handwritten forms. The results of the experiments in using the image limit endpoint method and rotational inertia characteristics to recognize 6,000 Chinese characters conducted by the Electronics Academy of the Ministry of Posts and Telecommunications, experiments in using character line length to recognize 3,000 printed form Chinese characters (at a speed of 3 characters/second) conducted by the Shenyang Automation Institute of the Chinese Academy of Sciences, the practical system of recognizing number form code of the Shanghai Public Utilities Institute, experiments using division mapping method extracted from the Chinese character stroke characteristics to differentiate 1,100 Chinese characters carried out by Institute No 52 of the Ministry of Electronics Industry, and restricted handwritten form Chinese character recognition of Qinghua University were universally welcomed at the meeting and people felt that they reflected the advanced level of work in these areas in China at present.

The representatives at the meeting felt that researching Chinese characters and automated recognition of Chinese characters are important topics in promoting the popularity of computers in China and are also a "bottleneck" to real breakthroughs in Chinese character computers and should be a point of emphasis in future Chinese language information processing technology research and development in China. To better guide and organize national automated recognition research, the meeting established an "Automated Recognition Study Group" (proposed). To catch up with international levels faster, the representatives felt that the key to work at present is to strengthen methodological research and tool research and that we should rapidly supply such devices as high precision digitizers, high speed and high capacity recognition dictionaries and high efficiency processors. The representatives also called on relevant departments to give greater attention to and actively support automated recognition technology.

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APPLIED SCIENCES

ENHANCING USE OF DOMESTIC COMPUTERS IN POWER SECTOR

Beijing DIANLI JISHU [ELECTRIC POWER] in Chinese No 7, 5 Jul 83 pp 2-6

[Article by Wang Pingyang [3769 1627 3152] and Wu Fengshu [0702 7685 2579] of Research Academy of Electric Power Science: "How To Improve the Application Level of Currently Available Domestically Made Computers in the Power Sector"]

[Text] At present, there are 130 computers of all descriptions (plus hundreds of micros) installed throughout the entire nation's electric power sector, the growth of which is shown in Figure 1. As shown in the figure, the overwhelming majority of computer mainframes were purchased in the 1970's, of which 90 percent were domestically produced, and 10 percent imported from other countries. Table 1 shows regional distribution, and Table 2 shows distribution by sectors. There are some 30 different types of minicomputers which account for the major proportion of computers in the country (internal memory < 0.5 MB, speed < 200,000 operations/second). General purpose computers with wordlengths of more than 30 bits are primarily used for designing and scientific computations; there are 10 types of mainframes which fall in this category, totaling 73 machines. There are also 20 types of computers, totaling 57 machines, which have wordlengths of less than 30 bits and are used chiefly for online monitoring. Main types of models are as follows: TQ-16 (28 mainframes), DJS-131 (16 mainframes), DJS-6 (9 mainframes), DJS-154 (8 mainframes), DJS-21 (8 mainframes), JS-10 (8 mainframes) and DJS-170 (7 mainframes).

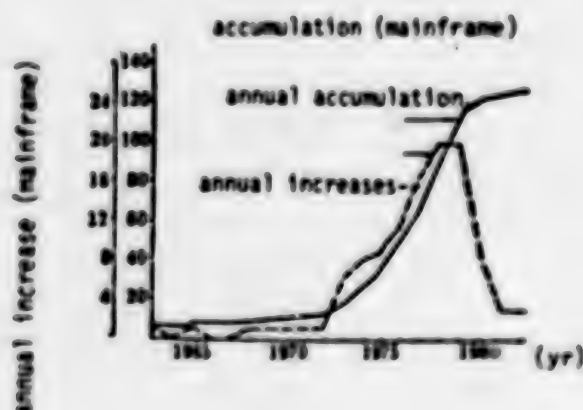


Figure 1. Computer Growth in Electric Power Sector

Table 1

<u>Region</u>	<u>Number of Mainframes</u>	<u>Percentage</u>
Northeast China	23	17.7
North China	39	30.0
Northwest China	10	7.7
East China	23	17.7
Central South China	25	19.2
Southwest China	10	7.7
Total	130	100.0

Table 2

<u>Sector</u>	<u>Number of Mainframes</u>	<u>Percentage</u>
Research and development	15	11.5
Designing	21	16.2
Bureaus of Power Production and Power Distribution	58	44.6
Hydro, thermal power plants	25	19.2
Schools	11	8.5
Total	130	100.0

For many years, these machines have contributed immensely to the electric power industry. First of all, they have played a major role in engineering and scientific computations, such as computing power grid flows, complex breakdown/short circuit current situations, operation stability, etc.; they have helped to determine power system operation modes, and insure safe and reliable operations. Other examples include computations for factory buildings pertaining to site preparation and structural design, power line and pylon designing, etc. Thanks to the computers, it was possible to complete these tasks on time, and save enormous amounts of capital for the country. Moreover, some results have also been achieved in computer-aided design and computer graphics. Some sectors have also started online safety monitoring work, using video display units to keep close watch over the status of power system operators, and promptly correct any abnormal conditions. Initial results have been achieved in this area. Some organizations have successfully improved enterprise management and work efficiency through information management and data processing. Besides, a certain amount of computing service is provided to outside organizations who pay for computer time.

According to 1980 statistics, approximately two-thirds of all the computer mainframes employed by the power sector throughout the country are in good running condition and can basically guarantee normal operations. Depending on the volume of work, general purpose computers are run one to two, or three shifts daily; online monitoring computers are run 24 hours daily. Machines which are in relatively poor condition account for approximately one-third;

some often malfunction and work less than one shift daily; some are still being debugged, and some cannot be used at all. In sum, the operational level and utilization ratio are not high at all. The problem lies in the poor reliability of certain machines, incompatible peripherals, poor software, incomplete application programs, lack of extensive use, relatively poor technical level of personnel, as well as some problems in technical policy and management.

In view of the preceding situation, the Scientific and Technical Committee of the former Ministry of Electric Power Industry entrusted our academy with the task of finding ways to improve the level of computer application and utilization ratio. Over the past 2 years, we held work sessions on all types of computers, conducted in-depth investigation and study, organized technical experience exchange meetings, research groups, and study groups. We also looked into ways of improving hardware reliability and software capabilities, and exchanged ideas. Some application software were straightened out; training was provided to help raise the technical level of personnel; rules and regulations for machine operation, maintenance, management and servicing were set up. The managers of quite a few organizations attached more and more importance to the use of computers. Through the efforts of all the computer personnel of various organizations under the Electric Power Ministry, and thanks to the warmhearted help of concerned manufacturers and institutions of higher education, the application level and utilization ratio of computers have improved remarkably. Now, approximately six-eighths of the computer mainframes are in good running condition.

As we are now trying to open up new prospects on all fronts, it is important to employ even more advanced and suitable computers. What is even more important, we must tap the potentialities of old equipment, and make good use of them. Following is a discussion on how to improve their application level and utilization ratio.

#### I. On Utilization Ratio

The State Planning Commission has set specific targets for the utilization ratio and effective computing time for the operation of domestically produced general-use computers. Assuming that there are 300 working days in a year, the targets are thus converted as follows: 6 hours of computer time per day for single shift system; 10 hours 40 minutes of computer time per day for double shift system; 15 hours of computer time per day for triple shift system. These are general targets for computer operation and management, and they serve as indexes for upkeeping computers and providing good computing services. Statistical forms are provided with computer maintenance rules for recording actual operational conditions. Through careful statistical work, the Huadong [East China] Electric Power Design Institute produced operational statistics of the institute's TQ-16 mainframe as shown in Table 3.

As compared to the State Planning Commission's targets, their computer up time is 59 percent over the quota; their effective computation time is 84 percent above quota, and maintenance down time is 49 percent shorter. It is hoped that other organizations in the power sector which have their own computers can also improve their computer utilization ratio and do solid statistical work reflecting

Table 3

<u>Time</u>	<u>Computer up time (hours)</u>	<u>Job run hours</u>	<u>Trial run hours</u>	<u>Idle time (hours)</u>	<u>Normal maintenance hours</u>	<u>Breakdown repair hours</u>
All of 1981	3,553.6	3,113.4	112.5	86.7	129.6	101.4
Jan-Jun 1982	2,324.8	2,116.1	57.5	40.5	59.6	54.2

their management level. As different organizations have different computing tasks to perform, their peak and off-peak hours are not evenly distributed. Some organizations do not have heavy workloads for their general purpose computers which are primarily used for running offline jobs; since their machines are frequently "hungry," it is suggested that they increase the number of users first by energetically expanding the application range within their own organizations and systems, and also by providing a certain amount of computer time to outside organizations.

## II. On Improving Reliability and Perfecting Peripheral Support

### 1. Improving Equipment Reliability

In recent years, remarkable improvements have been made in the reliability of domestically produced computer mainframes, and most machines are fairly stable. Some organizations had quality problems with machines which had been domestically produced in the early days; but with the support of the manufacturers who spent several years remodeling the systems and replacing an enormous quantity of parts, the reliability of these machines have improved, and most of the systems are now running in stable condition. Peripherals have quite a few problems. Photoelectric input devices, in particular, have always been the weakest link in our computer operations, i.e., accuracy problems frequently occur in inputs, and online time is wasted. Yantai Photoelectric Device Plant has come up with a new and reliable high quality product, and many organizations have achieved good results with this new product. Our 80 column line printers are another weak link; they are inferior to 160 column printers, and may very well become obsolete if the manufacturers fail to improve them.

Poor quality products must be dealt with by strengthening maintenance and repair services, and improving management level. Beginning from the TQ-16 model (which is a comparatively good make in China but somewhat inferior in quality to imported machines), regulations and guidelines on maintenance and repair have been put out for the chief kinds of mainframes in the power sector. Serious efforts are being made to carry out the regulations and guidelines, especially preventive check ups and maintenance. These are effective measures for maintaining high reliability. A computer room should be clean and kept at the proper temperature and humidity. It is important to put someone in charge of the equipment and make sure that the machines receive regular servicing and frequent maintenance. Whenever required, the equipment should be overhauled, thoroughly checked and debugged; bad parts should be replaced, and mechanical components should be cleaned and adjusted. It is important to keep the mainframes and peripherals in excellent running condition, and keep a tab on defects that cannot be corrected immediately.



## 2. Perfecting Peripheral Support

One of the major shortcomings of domestically made computer systems lies in the incomplete support of peripherals (external storage, input, output and related terminal equipment). Appropriate measures should be taken to remedy the situation.

In the beginning, the only kind of external storage equipment for domestically produced mainframes were magnetic drums which had small storage capacities and were difficult to service. Subsequently, some organizations got hold of magnetic tape drives which were only suitable for inputting and outputting massive data. Due to their inefficient access quality, the tape drives were not suitable for random accessing. Moreover, as domestically produced machines had poor interchangeability, plus the fact that magnetic powder came off the tapes, most users were not happy with their equipment. As domestically produced computers lacked external mass storage devices with good random access capability, it was difficult to provide multiple use software. It was also hard to perform large computation jobs, or meet the needs of information management and data processing. Now, the manufacturer has added a "duplex channel" in the TQ-16 model, allowing it to communicate with hard disk drives and 160 column line printers. It is possible to store frequently-used programs and data on disk storage, and load them into the memory whenever required, thus reducing input time and minimizing possible errors. The DJS-6 model can also be configured with hard disk drives. At present, foreign made computers are generally configured with hard disk storage units or floppy disk drives.

DJS-6, DJS-170 and DJS-183 machines in the power sector are now configured with CRT display units which are very convenient I/O devices and excellent results have been achieved in real time monitoring of power system operations. The Guangdong Electric Power Bureau utilizes the time gaps in video displaying or printing for offline computations, thus allowing a DJS-6 mainframe to make use of both its offline and online capabilities simultaneously and play the role of two machines. Besides, some organizations are experimenting with video display terminals on DJS-21 and TQ-16 mainframes.

In design departments, plotters are equally important computer peripherals. Several electric power designing institutes are already using computer plotters. The Northwest Electric Power Designing Institute has a TQ-16 driven plotter which can work 6 hours at a stretch and plot fairly complex diagrams. The Southwest Electric Power Designing Institute has gained practical experiences from their DJS-6 driven plotter. At present, it is necessary to further develop offline plotting so as to minimize the use of online time.

For some time, much has been said about developing Chinese character I/O equipment for computers. This is especially important for information management. We need to come up with an inexpensive way of developing Chinese character I/O devices for domestically manufactured mainframes.

### III. Perfecting Software and Expanding Software Capabilities

The key to maximizing the role of computers and improving utilization ratio lies in developing sufficient software support and enhancing software capabilities.

#### 1. System Software

Such software as operating systems, high level language compiling programs, utility programs, and diagnostic programs are generally provided by the computer manufacturer. However, in the past, there was very little software support for domestically produced computers; to this day, the software support is still far from perfect. Some software items are still in the process of being improved or further developed; some are already supported by disk operating systems, dual systems; some now have error checking and diagnostic programs; and there are more and more high level languages available. But there are still many deficiencies in most domestically produced computers. If their system software can be further developed, they can play a greater role. Software development requires no additional capital investment for equipment, but can prove to be quite profitable; thus, further efforts should be put into this type of development work.

#### 2. Application Software

The availability and quality of application software have direct bearing on the extensive use of computers. In recent years, through the joint efforts of the electric power sector and concerned organizations, as many as hundreds of special purpose programs have been developed, including all kinds of computation programs for power systems, electric equipment, poles, heat pipes, girders, frames, and construction. Other types of application software include some online monitoring programs for power systems, hydropower and thermal power plants, as well as some management data processing programs, computer plotting software, etc. There are a variety of commonly used power system software, such as programs for computing power system flows, short-circuit currents, dynamic/static stability, all kinds of malfunction operation modes, power system impact loads, relay protection/adjustment, reliability, economic power distribution, load prediction, power system growth planning, internal overvoltage, high voltage equipment static electricity fields, etc. Without such application programs, it would not have been possible for the computers to play such a great role as now. But the current inventory of application programs is far from sufficient, i.e., some programs are incomplete, some are redundant, and some are so poor in quality that they cannot be used at all. Thus, some effort should be made to overhaul our current stock of software. One measure is to establish a unified peer examination system, i.e., the Electric Power Ministry organizes an examination committee whose task is to produce unified examinations for testing the software programs of various organizations. Programs which pass the examinations are to be certified for use in production and designing work. Outstanding programs are to be reported as scientific achievements, and the developments are to be rewarded. Those which do not pass the examinations are required to be improved within a certain time frame. An examination was organized from March 1981 through October 1982 to test programs used for

computing power system flows, complex breakdown and static stability conditions. Eighty programs developed by 36 organizations were put to test. Some problems were discovered in quite a few programs which failed to produce the right answers; through repeated efforts, the programs were debugged and approved for practical use. A small number of programs simply failed to meet feasible requirements; recommendations were made to replace them with excellent programs developed by other organizations. In addition, another examination was organized in the electric power designing sector to test programs for civil engineering and electric power poles. These experiences should serve as references for future efforts to gradually examine and improve other application software. Maintenance support should be stressed for programs which are currently in use. Other corrective measures are: Cooperation groups for various types of computers, and all concerned organizations should carefully check their current inventory of software to see what is available and not available, and compile software directories. Published by the Huadong Electric Power Designing Institute, "A Short Guide to Specialized Programs for TQ-16 Computer" is a well-organized document containing 85 application programs, including 16 for power system, 4 for electricity, 7 for maintenance, 28 for circuitry, 8 for civil engineering, 12 for hydraulic, and 10 for surveying. Other TQ-16 users should do the same with programs which they have accumulated. It would be useful if they could share their software with other TQ-16 users, and start exchanging paper tapes and documents with others. To help popularize software, the documents should give full explanations on the use of programs. All computer cooperation groups should do the same, and different computer groups can help supply each other's needs as well through consultation and software transplantation. With more programs at his disposal, a computer user will have greater problem-solving capabilities and can make greater contributions as well.

Through preliminary overhauling efforts, it is now clear that our current inventory of software is far from sufficient. Moreover, there is dire need for certain categories of programs. We need to develop more and better programs, and replenish our software library, e.g., power system developing planning, economic analysis, online monitoring, information management, processing of scientific experiment data, etc. Such common resources should be developed through concerted efforts. It is important to have application people participate in software work, i.e., the only way to facilitate software development work is by combining the talents of programmers and application professionals. Software development is painstaking brain work requiring a great deal of manpower. As shown in Figure 2, the proportion of software investment is growing year by year in foreign countries. Software investments (including development and maintenance) in the United States and Japan have reached some 80 percent of the overall computer investments in those countries.

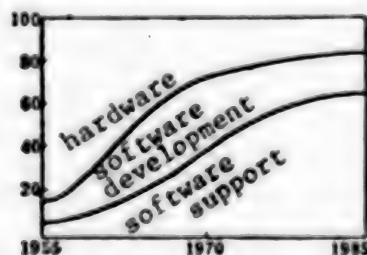


Figure 2. Computer Hardware/Software Investment Trends in Foreign Countries



#### IV. Increasing Personnel and Improving Their Technical Level

At present, there are approximately 1,500 persons in our power sector who are directly involved in computer work (an average of 11.5 persons per machine). Among them, approximately 60 percent are hardware professionals, and approximately 40 percent are software people; technicians account for 70 percent, workers account for 30 percent. The above figures tell us that, proportionally, the software people are on the low side. In the future, it is necessary to greatly reinforce the software force as computer applications grow in scope and depth.

To maximize the role of currently available computers, it is also necessary to improve the technical level of currently employed personnel. Over the last 2 years, we have organized study classes and research teams for different types of computers, placing special emphasis on system software training and exchanging of technical experiences. For sometime into the future, we need to step up application training.

Besides computer professionals, it is important to disseminate computer knowledge among professionals who specialize in various types of applications, thus helping the latter to get on the computer themselves. They should not only learn how to use programs that are suitable for their own specific fields, but also know how to expand the programs and develop new ones. To accomplish this, some professionals have to acquire additional knowledge on computational mathematics and algorithmic language. At our request, Xi'an Jiaotong University and Qinghua University organized nationwide study classes. Local study classes were organized in various places as well. In addition, computer classes for leading cadres were organized by the Nanjing Automation Research Institute on a number of occasions. All this has played a great role in promoting the extensive use of computers in our power sector.

#### V. Enhancing Management and Leadership

To maximize the role of currently available computers, improve their application level and utilization ratio, besides the preceding technical improvements, it is also necessary to improve management.

1. Formulate and implement rules and regulations on computer maintenance, management and servicing; clearly specify proper operating procedures, protection and maintenance requirements, and assessment standards. The standardized rules and regulations currently in force for TQ-16 and four other machines are also suitable for other types of computers.

2. Take good care of manpower resources. As there are widespread health hazard problems for those who work long hours in computer rooms, it is necessary to find appropriate ways of protecting their health during work.

3. Attach great importance to software development, maintenance and popularization. Some comrades can only see hardware and not software. Whether or not computers can be used properly and extensively depends on the quantity and quality of software. Thus, it is also important to increase investments in



software purchasing and development; appropriate policies and effective measures should be implemented to encourage all organizations and personnel to vigorously develop software.

4. Without affecting the use of their own computing needs, organizations should allow outside users to access their general-purpose computer mainframes, and expand the scope of service. Corresponding policies and measures should be adopted to encourage more use of the computer and improvement of utilization ratio (such as deducting a certain percentage from service charges for compensating equipment losses and paying bonuses).

5. For those organizations which are planning to add new computer equipment because their current equipment cannot meet their needs, it is important to choose state-recommended machine series and computers which will be developed by the power sector (e.g., large frame IBM series, PDP minicomputers). We must stop the previous practice of allowing organizations to choose different types of computers and act on their own which resulted in the chaotic use of all kinds of machine types throughout the whole country.

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APPLIED SCIENCES

MICROCOMPUTER PROGRAM FOR PLANNING ECONOMIC ADJUSTMENTS OF POWER SYSTEMS

Beijing DIANLI JISHU [ELECTRIC POWER] in Chinese No 7, 5 Jul 83 pp 6-11

[Article by Yu Erkeng [2456 1422 6972], Electric Power Science Research Institute of Ministry of Water Conservancy and Power Industry and Wu Yongxin [0702 3057 2450], Central Adjustment Office of Huabei Electric Power Bureau: "Using Microcomputers for Planning Daily Economic Adjustments of Beijing-Tianjin-Tangshan Power System"]

[Text] In July 1982, we developed a Zilog microcomputer program which can help make economic adjustments of electric power systems. Program capabilities include: forecast daily loads of power systems, find economic combination of generating units (i.e., generator operation plan) and economic distribution of effective power. Thanks to the reliability and convenience of the microcomputer, since September 1982 when it first went into production mode, the program has basically put an end to the history of making daily plans through manual work for Beijing-Tianjin-Tangshan Power System, and opened up new prospects of daily economic adjustment work.

Analysis of typical daily load plans shows that the daily plans generated by the computer program can help reduce coal consumption by 0.4 grams per kWh, or approximately 10,000 tons of standard coal per annum as compared with manually produced daily plans based on the principle of equi-infinitesimal increment rate.

Zilog is an 8-bit microcomputer. System hardware includes 64 kilobytes Z80 MPU, 8 inch single-sided single density hard sector floppy disks (2 drives), 12 inch B/W video monitor, and 132 column dot matrix printer.

The economic adjustment program was written in BASIC language. The least square method was used for daily load prediction; the coal consumption queueing method was used for finding economic combination of generating units; and the equation of compatibility method was used for economic distribution of effective power. The size of the program is approximately 2,000 statements which are divided into six main routines; the video display unit provides a convenient and visual means of retrieving, checking, modifying and storing data, as well as controlling computations.

Facts show that the microcomputer makes the planning of daily economic adjustments convenient, reliable and cost effective. It is suitable for actual conditions in China, and constitutes a powerful tool for economic adjustment of power systems.

## II. Algorithm of Microcomputer Economic Adjustment Program

As microcomputers have low computing capability and small memories, a fairly simple algorithm was chosen for the economic adjustment program.

### 1. Electric power system daily load forecasting

Using the least square method, it is possible to predict the load for the next 24 hours on the basis of load information (same load type) of the past 7 days.

#### (1) Daily load production mathematical model

As shown in Figure 1, this type of prediction uses a model which superimposes the linear increments of daily mean load over 24-hour period cyclic variations, i.e., the daily mean load variation is linear, but the ratio between the hourly mean load and daily mean load is characterized by 24-hour period cyclic variation.

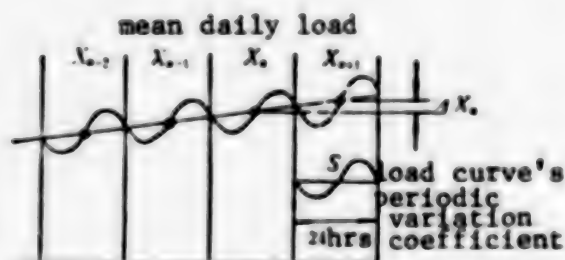


Figure 1. Daily Load Forecasting Model

The daily mean load of linear increments can be expressed as follows:

$$X_n = X_{n-1} + \Delta X_n \quad (1)$$

$$\Delta X_n = \Delta X_{n-1} \quad (2)$$

in which  $X_n$  — mean load on the  $n$ th day (tens of megawatts), i.e.,

$$X_n = \sum_{t=1}^{24} Z_{n,t} / 24 \quad (3)$$

$Z_{n,t}$  — mean load at hour No  $t$  on the  $n$ th day (tens of megawatts)

$\Delta X_n$  — mean load increment on the  $n$ th day (tens of megawatts)

Equation (2) indicates that the daily mean load increment within a short period of time is a constant, and the value is actually zero or approaching zero.

The 24-hour period cyclic load variation can be expressed as follows:

$$S_{n,t} = Z_{n,t} / X_n \quad (t = 1, 2, \dots, 24) \quad (4)$$

$$S_{n,t} = S_{n-1,t} \quad (t = 1, 2, \dots, 24) \quad (5)$$

in which  $S_{n,t}$  — periodic variation coefficient of load curve

Equation (5) shows that the periodic variation coefficient of the load curve within a short period of time does not change.

## (2) Algorithm for daily load prediction

Following is a formula for predicting daily mean load of linear increasing type:

$$\hat{X}_{n+1} = a_0 + a_1(n+1) \quad (6)$$

in which  $\hat{X}_{n+1}$  — mean load forecast value of (N+1)th day (tens of megawatts)  
 $a_0, a_1$  — constant term and first degree term

The optimum adaptive values of  $a_0$  and  $a_1$  are calculated with least square method using the actual daily mean load values of the last N days (N=7):

$$a_1 = \left( N \sum_{n=1}^N X_n - \sum_{n=1}^N X_n \sum_{n=1}^N n \right) \quad (7)$$

$$\div \left[ N \sum_{n=1}^N n^2 - \left( \sum_{n=1}^N n \right)^2 \right] \quad (8)$$

$$a_0 = \left( \sum_{n=1}^N X_n - a_1 \sum_{n=1}^N n \right) \div N$$

The constant-type periodic variation coefficient of the daily load curve comes directly from the mean value of the periodic variation coefficient of the recent-period actual load curve:

$$\hat{S}_{n+1,t} = \sum_{n=1}^N S_{n,t} / N \quad (t = 1, 2, \dots, 24) \quad (9)$$

Having obtained  $\hat{X}_{n+1}$ , which is the mean load of (n+1) days, and  $S_{n+1,t}$  ( $t = 1, 2, \dots, 24$ ), which is the load curve's periodic variation coefficient, it is possible to predict hour-by-hour loads of (n+1) days:

$$P_{D,t} = \hat{S}_{n+1,t} \cdot \hat{X}_{n+1} \quad (t = 1, 2, \dots, 24) \quad (10)$$

in which  $\hat{P}_{D,t}$  — load prediction value of t hours of the following day (tens of megawatts)



## 2. Economic combination of thermal generating units

The economic combination of generating units consists of properly arranging on/off times for the generators while insuring safety backups, thus enabling the power system to minimize its daily fuel consumption.

### (1) Mathematical expression of economic combination of generating units

Disregarding consumption incurred from starting up generating units, the goal function of economic combination of generating units is:

$$J_c = \sum_{i=1}^n \sum_{k=1}^M B_{k,i}(C_{k,i}, P_{k,i}) \rightarrow \min \quad (11)$$

in which  $J_c$  — power system's daily coal consumption (standard coal tons);  
 $k$  — generating unit sequence number,  $k = 1, 2, \dots, M$ ;  
 $C_{k,t}$  — on/off state of generating unit at  $t$  hour, 1 is on state, 0 is off state;  
 $P_{k,t}$  — power output of generating unit  $k$  at  $t$  hour (tens of megawatts) determined by economic distribution of load; and  
 $B_{k,t}$  — operational cost consumption of generating unit  $k$  at  $t$  hour (standard coal tons), which is the function of generating unit's on/off state and power output.

The power system is bound by the following safety backup condition:

$$\sum_{k=1}^M P_{k,\min} \cdot C_{k,t} \leq P_{D,t} \cdot K_s \leq \sum_{k=1}^M P_{k,\max} \cdot C_{k,t} \quad (t=1, 2, \dots, 24) \quad (12)$$

in which  $P_{k,\min}$  — minimum power limit of generating unit  $k$  (tens of megawatts);  
 $P_{k,\max}$  — maximum power limit of generating unit  $k$  (tens of megawatts);  
 $P_{D,t}$  — system load at  $t$  hour (tens of megawatts); and  
 $K_s$  — system load safety backup coefficient.

Under the condition of satisfying safety backup equation (12), the economic combination of generating units is accomplished by choosing the on/off states  $C_{k,t}$  of all generating units and minimizing the target function  $J_c$  in equation (11).

The coal consumption of generating units is:

$$\mu = B(P)/P \quad (13)$$

in which  $\mu$  — coal consumption of generating units (standard coal ton/tens of megawatt hour);  
 $P$  — power output of generating units (tens of megawatts);  
 $B(P)$  — coal consumption per hour (standard coal ton) when the power output of the generating unit is  $P$ .

While satisfying safety backup expression (12) and disregarding the start-up losses of generating units, it is possible to reduce the overall coal consumption by maximizing the role of generating units which consume less coal, i.e., minimizing the goal function in expression (11).

In practice, all generating units are lined up after using the mean network loss corrective rate  $(1-\sigma_k)$  to correct their mean operational coal losses:

$$u_k' = \frac{u_k}{1-\sigma_k} \quad (14)$$

In the preceding expression,  $\sigma_k = \partial P_L / \partial P_k$  is the network loss infinitesimal increment rate of generating unit  $k$ . Generating units that can be switched on/off within a system are lined up from low to high coal consumption rates  $u_k'$ , thus producing a table of sequences for starting generating units. By switching on generating units according to the sequence table until the sum of maximum power outputs satisfies the system's load requirements (plus safety backups), it is possible to produce economic combination of corresponding loads.

The Beijing-Tianjin-Tangshan power system is characterized by great coal consumption differences between the generating units, and the relatively low start/stop losses of generating units which can be turned off/off; in accordance with the actual characteristics, the program can produce a near-optimum combination plan.

### 3. Economic distribution of effective power among power plants

Under a combination of generating units, by allocating the outputs of power plants according to the system's loads in each time section, it is possible to minimize the system's daily coal consumption.

The program uses the classical method of compatibility equations; to simplify calculation, it assumes that the generating weight  $\gamma_i$  and network loss correction rate  $(1-\sigma_i)$  are provided.

#### (1) Mathematical model for economic distribution of effective power

The goal function for economic distribution of effective power among power plants is:

$$J_0 = \sum_{i=1}^n \sum_{t=1}^m B_{i,t}(P_{i,t}) \rightarrow \min \quad (15)$$

In which  $J_0$  — system's daily coal consumption (standard coal ton);  
 $i$  — sequence number of thermal plant,  $i = 1, 2, \dots, n$ ;  
 $P_{i,t}$  — mean output of thermal plant  $i$  in time section  $t$  (tens of megawatts);  
 $B_{i,t}$  — mean coal consumption of thermal plant  $i$  in time section  $t$  (standard coal ton).

This is limited by the system's power balance:

$$P_{D,t} + P_{L,t} - \sum_{i=1}^n P_{i,t} = 0$$

$$(t = 1, 2, \dots, 24)$$
(16)

in which  $P_{D,t}$  -- system load in time section  $t$  (tens of megawatts);  
 $P_{L,t}$  -- system network losses in time section  $t$  (tens of megawatts).

The economic distribution of the effective power of thermal power plants can be summed up as follows: While working within the equality constraints of equation (16), the distribution of power plant outputs ( $P_{i,t}$ ) should minimize the goal function  $J_D$  in expression (15).

## (2) Algorithm for economic distribution of effective power

Introduce Lagrange multiplier  $\lambda_t$  ( $t=1, 2, \dots, 24$ ) into the equality constraints of expression (16) so as to transform the conditional extreme values into unconditional extreme-value problem, and thus produce the following equation of compatibility for economic distribution of effective power:

$$\frac{b_{i,t}}{1 - \sigma_{i,t}} = \lambda_t$$

$$(i = 1, 2, \dots, n; t = 1, 2, \dots, 24)$$
(17)

in which  $b_{i,t}$  -- the infinitesimal increment rate of coal consumption of plant  $i$  in time section  $t$  (standard coal ton/hour/tens of megawatts),

that is:

$$b_i = \frac{dB_i}{dP_i} = f_i(P_i)$$
(18)

$f_i(P_i)$  shows that the coal consumption infinitesimal increment rate of power plant  $i$  is the function of the plant's output, and is expressed by multiple-sectioned broken lines (Figure 2) by the program.



Figure 2. Power Plant Coal Consumption Infinitesimal Increment Rate Curve

$\sigma_i$  -- power plant  $i$ 's network loss infinitesimal increment rate, i.e.,

$$\sigma_i = \frac{\partial P_i}{\partial P_i}$$

$\lambda_1$  — system power balance condition multiplier which varies with system load and combination of generating units.

In practical use, a generating weight  $\gamma_i$  is introduced into each power plant, and equation (17) becomes:

$$\frac{b_{i,t} \cdot \gamma_i}{1 - \sigma_{i,t}} = \lambda_1$$

( $i = 1, 2, \dots, m; t = 1, 2, \dots, 24$ )

(19)

and the system power condition is changed to:

$$P_{D,t} - \sum_{i=1}^m P_{i,t} = 0 \quad (t = 1, 2, \dots, 24)$$
(20)

in which  $P_{D,t}$  — predicted value of system load in time section  $t$ , which is included in network losses

The generating weight  $\gamma_i$  is used for adjusting the electric energy production of power plant  $i$  in the economic distribution system. When  $\gamma_i = 1$ , power plant  $i$  distributes the quantity of electricity normally according to the equation of compatibility; when  $\gamma_i > 1$ , power plant  $i$  reduces its power generation; when  $\gamma_i < 1$ , power plant  $i$  increases its production. In practical use, it is used for cutting down the production of some oil-fired power plants, or increasing the production of some power plants to insure power needs of local security systems.

In order to accurately control the daily consumption of fuels (coal, oil or water) allocated to power plants, it is necessary to perform iterative computation of  $\gamma_i$  to meet fuel balance conditions. But due to the tremendous amount of computation involved, a medium-scale computer mainframe is used for this type of computation temporarily.

The network loss correction rates  $(1 - \sigma_i)$  of power plants constitute the function of power plant outputs. To minimize computation, the power plants use mean values for the entire day, and a medium-scale mainframe is temporarily employed for this type of computation.

Given the combinations, generating weights, and network correction rates, finding the power outputs of power plants to satisfy expressions (19) and (20) becomes a one dimensional nonlinear equation problem. By using the Newton interpolation method in the program's iterative calculation routine, it is possible to insure convergence under the condition of the power plants' infinitesimal increment characteristics (including vertical sections and horizontal sections).



### III. Characteristics of the Microcomputer Economic Adjustment Program

Experiences from large and medium frame machines do not always apply to micro-computer programming. Microcomputers are reliable, convenient, and have large external storages; but they are slow and have limited internal memories. To take advantage of their strong points and overcome their weaknesses, the following measures were adopted in programming:

1. Algorithms were simplified as much as possible, using least square method for predicting daily loads, coal consumption queueing method for economic combination of generating units, and equation of compatibility method of given generating weights and network correction rates  $(1 - \sigma)$  for economic distribution of effective powers. These algorithms greatly reduced computing work without losing much accuracy.
2. Fully utilized video monitor's visual effects and programming language's interactive capability, i.e., such routines as calling up program, controlling computing processes, retrieving data, checking data, modifying data and storing data are all performed interactively on the screen, thus insuring the accuracy of data, as well as convenience and flexibility of the program.
3. Fully utilize floppy disk storage. The entire economic adjustment program is divided into six parts which are stored in six separate files on the floppy; large data sets are also stored on the floppy as data files. To overcome the micro's limited memory, only one part of the program is called into the memory at a time whenever needed in the course of computation.
4. The computerized economic adjustment printouts should have the same format as the original manual planning forms so that the workers in the control room will not have difficulty adapting to the printouts.
5. By using generating weights  $\gamma$  for controlling distribution of power plant electricity, it is possible to bring initial planning on the computer as close as possible to manual planning; this will enable the control room personnel to quickly adapt to the new system and avoid drastic changes when switching over from manual planning to computerized planning.

### IV. Overview of Zilog Microcomputer Economic Adjustment Program

The whole program is divided into six program units, as shown in Figure 3. Following is a brief explanation.

1. FBPB--Program for modifying power plant's infinitesimal increment b-P curve

Program Function: Display, modify, add or remove b-P curve, store information into file "BPB" for use by programs OPC, TUC and EDC.

Program Size: 220 statements

Run time: Varies according to volume of modification, approximately several minutes.

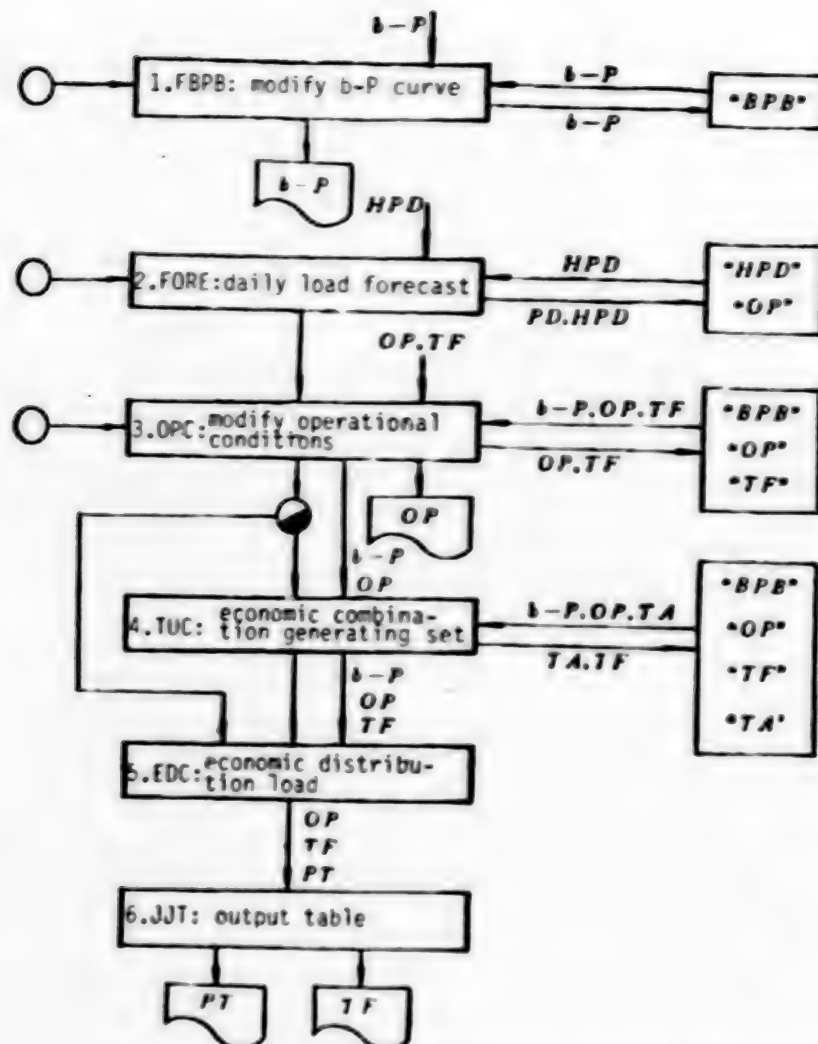


Figure 3. Basic Composition of Economic Adjustment Program

## 2. FORE--Daily load forecasting program

**Program Function:** Based on recent load data (HPD) and using least square method, the program predicts the load for next 24 hours (PD), stores the information in the operational condition file (OP) for use by programs TUC, EDC and JJT.

**Program Size:** 180 statements.

**Run Time:** Approximately 40 seconds.

## 3. OPC--Program for modifying operational conditions

**Program Function:** Interactively modify operational conditions "OP" which include the following contents:

- (1) PD--load curve;
- (2) PC--fixed output plan curve;
- (3) PX--list of power plants' maximum output limits;
- (4) PI--list of power plants' minimum output limits;
- (5) SG--list of power plants' network loss correction rates;
- (6) GM--list of power plants' generating weights.

On completion of modification, "OP" is put back in the storage file for use by programs TUC, EDC and JJT.

Program Size: 380 statements.

Run Time: Varies according to volume of modification, approximately 10 minutes.

#### 4. TUD--Program for finding economic combination of generating units

Program Function: From table of next day's available combinations "TA," the program uses the coal consumption queueing method, to compile a list of economic combination of generating units which satisfies load PD and standby requirements; the list is stored in file "TF" for use by programs EDC and JJT.

Program Size: 420 statements.

Run Time: Approximately 2 minutes.

#### 5. EDC--Program for economic distribution of load

Program Function: Using data from files "BPB," "TF," and "OP," the program generates a 24-hour plan for the distribution of outputs of all power plants ("PT") for use by program JJT.

Program Size: 380 statements.

Run Time: Not more than 10 minutes.

#### 6. JJT--Program for formulating daily plan table for Beijing-Tianjin-Tangshan power system

Program Function: Outputs the next day's output plans for all power plants in the Beijing-Tianjin-Tangshan power system.

Program Size: 380 statements.

Run Time: Approximately 3 minutes.

### V. Microcomputers Are a Powerful Tool for Current Drive To Materialize the Economic Adjustments of Power Systems

Through more than 10 months of operational use in the Beijing-Tianjin-Tangshan power system, the Zilog economic adjustment program has shown the following advantages:

### 1. High degree of reliability

Operational conditions data for the following day are gathered each morning and entered into the computer at 10:00-11:00; it takes approximately half an hour to complete next day's plan for the economic distribution of outputs from all power plants. The plan is signed by the control manager and delivered to the control room before 12:00 noon. This procedure is followed every day without exception, and has already become a system. Up to now, the medium-scale computer mainframe has not been able to achieve the same degree of reliability.

### 2. Easy to use

Data on operating conditions and generating unit characteristics are stored in floppy disks and modified each day through the video display unit which has excellent visual effects and is quite easy to use. The perfected interactive system enables the professional staff to monitor and control the entire computational process. The system is easy to learn, and helps reduce errors.

The printouts can be directly used in the control room and there is no further need for the control room operator to copy the tables.

### 3. Low cost

At present, an 8-bit microcomputer costs about 50,000 yuan (RMB), but it can bring about economic adjustments [of the power system] which translates into hundreds of thousands, even millions of youan worth of beneficial economic results each year. In addition, the system requires only a minimal amount of work for installation and maintenance.

### 4. Conducive for technical training

Microcomputers are simple and easy to master and do not require professional programmers to operate at all. It takes only a couple of days for the control room people to learn how to operate the microcomputer and run the economic adjustment program by themselves. It enables us to accumulate economic adjustment experiences (and data) and improve our technical level at the same time, thus paving the way for the introduction of more advanced computers.

Based on the preceding four points, it is not difficult to see that microcomputers constitute a powerful tool for the current drive to realize economic adjustments of power systems. At present, the control departments in Zhejiang, Shandong and Sichuan Provinces have already gathered information, and it will not be long before the program is adapted to their machines. More power systems are prepared to purchase microcomputers for economic adjustment work. Thus, the authors suggest the following:

1. All control bureaus (especially outlying provinces and regions) should purchase microcomputers as soon as possible for their own economic adjustment systems, and thus benefit early from the realization of economic adjustments.



2. Using the current economic adjustment program of Beijing-Tianjin-Tangshan power network as starting point, popularize the software energetically, share and improve the software together, and develop new editions each year.

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(The preceding references were compiled by Yu Erkeng [2456 1422 6972] and Wu Yongxin [0702 3057 2450], and published by the Electric Power Science Research Institute and Central Adjustment Office of Huabei Electric Power Bureau.)

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APPLIED SCIENCES

DYNAMIC SIMULATION OF DC TRANSMISSION SYSTEM

Beijing DIANLI JISHU [ELECTRIC POWER] in Chinese No 7, 5 Jul 83 pp 12-18

[Article by Ren Zhen [0117 7201] of Electrical Engineering Department, Chongqing University: "Dynamic Simulation of Direct Current Transmission System--Application of State-Space Variables Equation"]

[Text] I. Introduction

In recent years, the remarkable increase of the speed of digital computers has produced tremendous impact on the development of certain complex computer programs for research on DC transmission. Moreover, due to the development of DC transmission systems, it is becoming increasingly felt that similarity simulations can no longer fully meet the requirements of complex structured systems of high precision. Thus, some computer applications have been developed for DC transmission systems. However, as compared with AC power systems, such applications are clearly far from adequate.

Dynamic simulation is a fairly important topic in the field of research on DC transmission systems. This is due to the fact that the periodic on-off states of controllable valves in converter bridges constantly change the system structure, and each kind of structure represents a state. The problem not only lies in the need to compute current distributions under each state, but also the logical relations between the states. Moreover, it is imperative to accurately compute the phase change time which is an important operational parameter in DC transmission. Besides, a series of problems will also crop up when performing mathematical processing of the ever-changing network topologies.

J.L. Hay and B.T. Ooi propose to use special computer programs for studying the dynamic simulation of DC transmission systems.<sup>2-3,5-6</sup> They used the linear system theory for studying the convergence of steady-state solutions, and Newton's iteration method for computing phase change time, thus conserving on-line time. Their achievement is worth recommending.

If we want to further conserve online time and cost, it is extremely useful to find out how to fully utilize the symmetric relations between different subinterval topographies, and minimize the number of iterative sessions it takes to solve characteristic values and characteristic vectors. Based on these principles, the author has developed a fairly satisfactory computer program.

## II. State Space Variables Equations and Solutions

Under ordinary circumstances, the state space variables equations is written in the following form<sup>2</sup>:

$$\dot{\underline{x}}_k = \underline{f}_k(\underline{x}_k, t) \quad t_{k-1} < t \leq t_k, \quad k=1, 2, 3, \dots \quad (1)$$

in which  $\underline{x}_k$  —  $n_k$  dimension state variable  
 $k$  — number of subintervals

According to Kirchhoff's voltage law and current law, equation (1) can become a linear equation as follows:

$$[L_k]\dot{\underline{x}}_k + [R_k]\underline{x}_k = [G_k]\underline{u}_k \quad (2)$$

in which  $[L_k]$  —  $n_k \times n_k$  inductance matrix;  
 $[R_k]$  —  $n_k \times n_k$  resistance matrix;  
 $[G_k]$  —  $n_k \times m_k$  excitation function vector constant matrix;  
 $\underline{u}_k$  — excitation function vector

$$\underline{u}_k = \begin{bmatrix} e_k \\ e_k \\ e_k \\ I_k \end{bmatrix} \quad (3)$$

in which  $I_k$  — DC side current  
 $e_k, e_k, e_k$  — AC side external 3-phase power supply

$$\left. \begin{aligned} e_k &= E_m \sin(\omega t + \pi/6 + \alpha) \\ e_k &= E_m \sin(\omega t - \pi/2 + \alpha) \\ e_k &= E_m \sin(\omega t + 5\pi/6 + \alpha) \end{aligned} \right\} \quad (4)$$

in which  $\alpha$  is lag angle.

Equation (2) can also take the following form:

$$\dot{\underline{x}}_k = [A_k]\underline{x}_k + [B_k]\underline{u}_k \quad (5)$$

in which  $[A_k]$  —  $n_k \times n_k$  constant matrix

$$[A_k] = -[L_k]^{-1}[R_k] \quad (6)$$

$[B_k]$ — $n_k \times m_k$  constant matrix

$$[B_k] = [L_k]^{-1} [G_k] \quad (7)$$

To simplify calculation, substitute (3) for (4), thus:

$$\begin{aligned} \underline{u}_k &= \begin{bmatrix} e_1 \\ e_2 \\ e_3 \\ I_4 \end{bmatrix} = \begin{bmatrix} E_m \sin(\omega t + \pi/6 + \alpha) \\ E_m \sin(\omega t - \pi/2 + \alpha) \\ E_m \sin(\omega t + 5\pi/6 + \alpha) \\ I_4 \end{bmatrix} \\ &= \begin{bmatrix} E_m \sin \omega t \cos(\pi/6 + \alpha) + E_m \\ \times \cos \omega t \sin(\pi/6 + \alpha) \\ E_m \sin \omega t \cos(\pi/2 + \alpha) - E_m \\ \times \cos \omega t \sin(\pi/2 + \alpha) \\ E_m \sin \omega t \cos(5\pi/6 + \alpha) + E_m \\ \times \cos \omega t \sin(5\pi/6 + \alpha) \\ I_4 \end{bmatrix} \\ &= \cos \omega t \begin{bmatrix} E_m \sin(\pi/6 + \alpha) \\ -E_m \cos \alpha \\ E_m \sin(5\pi/6 + \alpha) \\ 0 \end{bmatrix} \\ &\quad + \sin \omega t \begin{bmatrix} E_m \cos(\pi/6 + \alpha) \\ E_m \sin \alpha \\ E_m \cos(5\pi/6 + \alpha) \\ 0 \end{bmatrix} \\ &\quad + \begin{bmatrix} 0 \\ 0 \\ 0 \\ I_4 \end{bmatrix} \\ &= \cos \omega t \underline{a}_k + \sin \omega t \underline{b}_k + \underline{c}_k \quad k=1, 2, 3, \dots \end{aligned} \quad (8)$$

in which follows:

$\underline{a}_k$ ,  $\underline{b}_k$  and  $\underline{c}_k$  are  $m_k$  dimensional vectors and are obtained as

$$\underline{a}_k = \begin{bmatrix} E_m \sin(\pi/6 + \alpha) \\ -E_m \cos \alpha \\ E_m \sin(5\pi/6 + \alpha) \\ 0 \end{bmatrix} \quad (9)$$

$$\underline{b}_k = \begin{bmatrix} E_m \cos(\pi/6 + \alpha) \\ E_m \sin \alpha \\ E_m \cos(5\pi/6 + \alpha) \\ 0 \end{bmatrix} \quad (10)$$

$$\underline{c}_k = [0 \quad 0 \quad 0 \quad I_4]^T \quad (11)$$



The following is obtained from the solution of state variable equation (5):

$$\underline{x}_s(t) = \cos \omega t \underline{g}_s + \sin \omega t \underline{h}_s + \underline{d}_s + (\exp[A_s](t-t_{s0})) \underline{W}_s \quad (12-a)$$

$$\underline{W}_s = \underline{x}_s(t_{s0}) - \cos \omega t_{s0} \underline{g}_s - \sin \omega t_{s0} \times \underline{h}_s - \underline{d}_s \quad (12-b)$$

in which  $n_s$  dimensional vectors  $\underline{g}_s$ ,  $\underline{h}_s$  and  $\underline{d}_s$  can be obtained through the following linear simultaneous equations:

$$[A_s] \underline{d}_s = -[B_s] \underline{c}_s \quad (13)$$

$$\begin{bmatrix} -[A_s] & \omega[I] \\ -\omega[I] & -[A_s] \end{bmatrix} \begin{bmatrix} \underline{g}_s \\ \underline{h}_s \end{bmatrix} = \begin{bmatrix} [B_s] \underline{c}_s \\ [B_s] \underline{b}_s \end{bmatrix} \quad (14)$$

the solutions of which are:

$$\underline{d}_s = -[A_s]^{-1} [B_s] \underline{c}_s \quad (15)$$

and

$$\begin{bmatrix} \underline{g}_s \\ \underline{h}_s \end{bmatrix} = \begin{bmatrix} -[A_s] & \omega[I] \\ -\omega[I] & -[A_s] \end{bmatrix}^{-1} \begin{bmatrix} [B_s] \underline{c}_s \\ [B_s] \underline{b}_s \end{bmatrix} \quad (16)$$

In equation (12-a),  $\exp[A_s](t-t_{s0})$  is state transition matrix. There are many ways of solving this matrix; in this paper, a special standard subroutine is used to compute the characteristic value and characteristic vector of  $[A_s]$ , from which all the state variables can be calculated. Thus:

$$[A_s] = [M_s] [A_s] [M_s]^{-1} \quad (17)$$

in which

$[A_s]$  — characteristic value's diagonal matrix

$[M_s]$  — characteristic vector matrix

From (17), the state transition matrix becomes:

$$\exp[A_s](t-t_{s0}) = [M_s] \exp[A_s] \times (t-t_{s0}) [M_s]^{-1} \quad (18)$$

At this point, all the variables in equations (12-a) and (12-b) are either known or obtainable, and the state variables are also obtainable.

### III. Network Topography

The circuit in Figure 1 has a Graetz Bridge composed of six controllable silicon valves  $V_1$ - $V_6$ . The DC current side is connected to a steady current source  $I_d$ ; the AC current side is connected to a synchronous generator via a transformer whose impedances are  $R_T$  and  $X_T$ . The potentials of the generator are  $e_a$ ,  $e_b$  and  $e_c$ , and its impedances are  $R_s$  and  $L_s$ . The AC side has a load whose impedances are  $R$  and  $L$ . For the purpose of analysis and computation, the following conditions are assumed: the 3-phase potentials in the AC side are symmetric, the 3-phase circuit is balanced, and the current  $I_d$  in the DC side is steady.

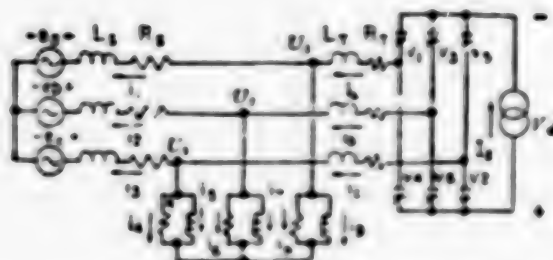


Figure 1. Equivalence Circuit With Graetz Bridge Inverse Converter

The circuits in Figure 2(a) show the phase changing process. Based on Kirchhoff's voltage law and current law, it is not difficult to arrive at the following set of equations:

subinterval  $K = 1$

Let state variable  $\underline{x}_1(t)^T = [i_1(t) \ i_2(t) \ i_3(t) \ i_4(t) \ i_5(t) \ i_6(t)]$ ,

Thus

$$\begin{bmatrix} -2L_s & -L_s & 0 & L & -L & 0 \\ L_s & -L_s & L & -L & 0 & 0 \\ 0 & 0 & L/R & 0 & L/R & 0 \\ 0 & 0 & 0 & L/R & 0 & 0 \\ 0 & 0 & 0 & 0 & L/R & 0 \\ 2L_s & L_s & 0 & 0 & 0 & 2L_s \end{bmatrix} \times \begin{bmatrix} \frac{d i_1(t)}{dt} \\ \frac{d i_2(t)}{dt} \\ \frac{d i_3(t)}{dt} \\ \frac{d i_4(t)}{dt} \\ \frac{d i_5(t)}{dt} \\ \frac{d i_6(t)}{dt} \end{bmatrix}$$

$$\begin{aligned}
& + \begin{bmatrix} -2R_s & -R_s & 0 & 0 & 0 & 0 \\ R_s & -R_s & 0 & 0 & 0 & 0 \\ -1 & 0 & 1 & 0 & 1 & 0 \\ 1 & 0 & 0 & 1 & 0 & 0 \\ -1 & -1 & 0 & 0 & 1 & 0 \\ 2R_s & R_s & 0 & 0 & 0 & 2R_r \end{bmatrix} \\
& \times \begin{bmatrix} i_1(t) \\ i_1(t) \\ i_2(t) \\ i_1(t) \\ i_2(t) \\ i_2(t) \end{bmatrix} \\
& = \begin{bmatrix} -1 & 1 & 0 & 0 \\ 0 & -1 & 1 & 0 \\ 0 & 0 & 0 & -1 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & -1 \\ 1 & 0 & -1 & -R_r \end{bmatrix} \begin{bmatrix} e_s(t) \\ e_s(t) \\ e_s(t) \\ I_s(t) \end{bmatrix} \quad (19)
\end{aligned}$$

Therefore:

$$[L_s] = \begin{bmatrix} -2L_s & -L_s & 0 & L & -L & 0 \\ L_s & -L_s & L & -L & 0 & 0 \\ 0 & 0 & L/R & 0 & L/R & 0 \\ 0 & 0 & 0 & L/R & 0 & 0 \\ 0 & 0 & 0 & 0 & L/R & 0 \\ 2L_s & L_s & 0 & 0 & 0 & 2L_r \end{bmatrix} \quad (20)$$

$$[R_s] = \begin{bmatrix} -2R_s & -R_s & 0 & 0 & 0 & 0 \\ R_s & -R_s & 0 & 0 & 0 & 0 \\ -1 & 0 & 1 & 0 & 1 & 0 \\ 1 & 0 & 0 & 1 & 0 & 0 \\ -1 & -1 & 0 & 0 & 1 & 0 \\ 2R_s & R_s & 0 & 0 & 0 & 2R_r \end{bmatrix} \quad (21)$$

$$[G_s] = \begin{bmatrix} -1 & 1 & 0 & 0 \\ 0 & -1 & 1 & 0 \\ 0 & 0 & 0 & -1 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & -1 \\ 1 & 0 & -1 & -R_r \end{bmatrix} \quad (22)$$

After obtaining  $[L_1]$ ,  $[R_1]$  and  $[G_1]$ , it is not hard to find constant matrixes  $[A_1]$  and  $[B_1]$  through equations (6) and (7):

$$[A_1] = -[L_1]^{-1}[B_1] \quad (23)$$

$$[B_1] = [L_1]^{-1}[G_1] \quad (24)$$

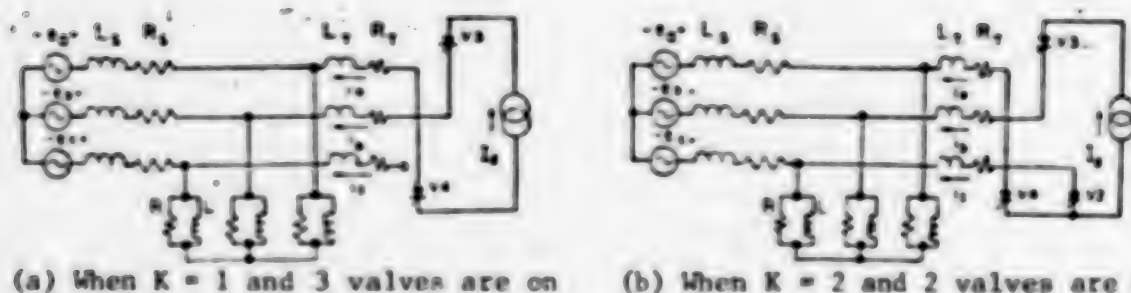


Figure 2. Network Topographies

With equations (15) and (16),  $\underline{g}_1$ ,  $\underline{h}_1$  and  $\underline{d}_1$  can be obtained by solving the set of equations. But based on  $[A_1]$ , and with equation (17), it is possible to find the diagonal matrix  $[\Lambda_1]$  of the characteristic value as well as the characteristic vector matrix  $[M_1]$  and its inverse matrix  $[M_1]^{-1}$ . By substituting the preceding values, vectors and matrixes into equations (12-a) and (12-b), it is possible to find all of the solutions to  $i_2$ ,  $i_3$ ,  $i_5$ ,  $i_7$  and  $i_C$  which are the six state variables when subinterval  $K=1$ . Furthermore, the value of  $i_1$  can be solved through the relation  $i_1 + i_2 + i_3 = 0$ .

The circuit in Figure 2(b) represents a nonphase-change network topography. Similarly, it is possible to obtain a set of equations for  $K=2$ .

Subinterval  $K=2$   
Let state variable

thus:

$$\begin{bmatrix} -2L_1 & -L_1 & 0 & L & -L \\ L_1 & -L_1 & L & -L & 0 \\ 0 & 0 & L/R & 0 & L/R \\ 0 & 0 & 0 & L/R & 0 \\ 0 & 0 & 0 & 0 & L/R \end{bmatrix} \times \begin{bmatrix} \frac{di_1(t)}{dt} \\ \frac{di_2(t)}{dt} \\ \frac{di_3(t)}{dt} \\ \frac{di_5(t)}{dt} \\ \frac{di_7(t)}{dt} \end{bmatrix} + \begin{bmatrix} -2R_1 & -R_1 & 0 & 0 & 0 \\ R_1 & -R_1 & 0 & 0 & 0 \\ -1 & 0 & 1 & 0 & 1 \\ 1 & 0 & 0 & 1 & 0 \\ -1 & -1 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} i_1(t) \\ i_2(t) \\ i_3(t) \\ i_5(t) \\ i_7(t) \end{bmatrix}$$



$$x \begin{bmatrix} i_a(t) \\ i_b(t) \\ i_c(t) \\ i_r(t) \\ i_s(t) \end{bmatrix} = \begin{bmatrix} -1 & 1 & 0 & 0 \\ 0 & -1 & 1 & 0 \\ 0 & 0 & 0 & -1 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & -1 \end{bmatrix} \begin{bmatrix} e_a(t) \\ e_b(t) \\ e_c(t) \\ i_s \end{bmatrix} \quad (25)$$

Therefore

$$[L_s] = \begin{bmatrix} -2L_s & -L_s & 0 & L & -L \\ L_s & -L_s & L & -L & 0 \\ 0 & 0 & L/R & 0 & L/R \\ 0 & 0 & 0 & L/R & 0 \\ 0 & 0 & 0 & 0 & L/R \end{bmatrix} \quad (26)$$

$$[R_s] = \begin{bmatrix} -2R_s & -R_s & 0 & 0 & 0 \\ R_s & -R_s & 0 & 0 & 0 \\ -1 & 0 & 1 & 0 & 1 \\ 1 & 0 & 0 & 1 & 0 \\ -1 & 1 & 0 & 0 & 1 \end{bmatrix} \quad (27)$$

$$[G_s] = \begin{bmatrix} -1 & 1 & 0 & 0 \\ 0 & -1 & 1 & 0 \\ 0 & 0 & 0 & -1 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & -1 \end{bmatrix} \quad (28)$$

With the same method, it is possible to obtain all of the state variables for subinterval  $K = 2$ .

For  $K = 3, 4, 5, \dots, 12$ , the same principles can be applied towards finding all the state variables of each and every subinterval.

The state variables selected for the 12 subintervals are shown in Table 1. The only reason for choosing state variables for all subintervals in this manner is to reduce the number of iterative sessions needed for solving characteristic vector matrixes  $[A_k]$  and characteristic vector matrixes  $[M_k]$  by causing the odd and even number subintervals to have equal inductance matrixes  $[L_k]$  and resistance matrixes  $[R_k]$ , and thus conserve online time and cost.

#### IV. Phase Changing Time

Figure 3 shows the variation pattern of transformer valve side currents  $i_a$ ,  $i_b$  and  $i_c$  when the inverse converter shuts on and off according to a regular and normal switching pattern. A time period  $T$  is divided into six equal parts; each part is composed of two subintervals. The former subinterval is the phase-changing subinterval whose length is phase-changing time  $\mu$ ; the latter subinterval is the nonphase-changing subinterval whose length equals  $T/6 - \mu$ .

Table 1. State Variables Selected for Each Subinterval

Sub-interval K	State variables					
	$\underline{x}_1(t)$	$\underline{x}_2(t)$	$\underline{x}_3(t)$	$\underline{x}_4(t)$	$\underline{x}_5(t)$	$\underline{x}_6(t)$
1	$i_1$	$i_2$	$i_3$	$i_4$	$i_5$	$i_6$
2	$i_1$	$i_2$	$i_3$	$i_4$	$i_5$	$i_6$
3	$-i_1$	$-i_2$	$-i_3$	$-i_4$	$-i_5$	$-i_6$
4	$-i_1$	$-i_2$	$-i_3$	$-i_4$	$-i_5$	$-i_6$
5	$i_1$	$i_2$	$i_3$	$i_4$	$i_5$	$i_6$
6	$i_1$	$i_2$	$i_3$	$i_4$	$i_5$	$i_6$
7	$-i_1$	$-i_2$	$-i_3$	$-i_4$	$-i_5$	$-i_6$
8	$-i_1$	$-i_2$	$-i_3$	$-i_4$	$-i_5$	$-i_6$
9	$i_1$	$i_2$	$i_3$	$i_4$	$i_5$	$i_6$
10	$i_1$	$i_2$	$i_3$	$i_4$	$i_5$	$i_6$
11	$-i_1$	$-i_2$	$-i_3$	$-i_4$	$-i_5$	$-i_6$
12	$-i_1$	$-i_2$	$-i_3$	$-i_4$	$-i_5$	$-i_6$

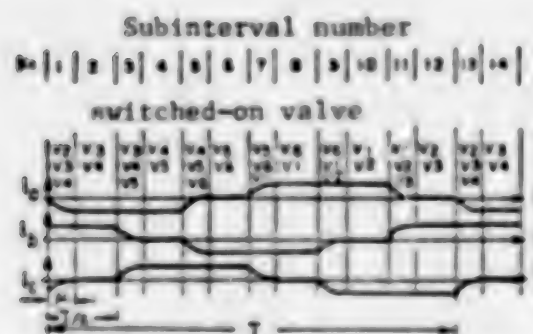


Figure 3. Variation Pattern of Transformer Valve Side Current

With Newton's iterative method, it is possible to accurately calculate the phase changing time of each and every odd number subinterval. Newton's iterative method can be written

$$\mu_{n+1} = \mu_n - \frac{x_{1j}(\mu_n)}{\dot{x}_{1j}(\mu_n)} \quad (29)$$

in which

$n$  -- number of iterations  
 $x_{1j}$  -- element No  $j$  of vector  $\underline{x}_1$  in equation (12)  
 $\dot{x}_{1j}$  -- linear differential of  $x_{1j}$

when  $x_{1j}(\mu_n) = 0$  (30)

then  $\mu_{n+1} = \mu_n$  in equation (29) is the solution.

The following steps can be used for finding the solution:

1. to find  $\underline{q}_k$

$$\underline{q}_k = [M_k]^{-1} \{ \underline{x}_k(t_k) - \cos \omega t_k \underline{g}_k - \sin \omega t_k \underline{h}_k - \underline{d}_k \} \quad (31)$$

Equation (31) is computed only once for each subinterval. This is because the value of  $\underline{q}_k$  remains constant throughout each subinterval.

2. Compute

$$x_{kj}(\mu_k) = \cos \omega \mu_k g_{kj} + \sin \omega \mu_k h_{kj} + d_{kj} + \sum_{i=1}^k m_{ii} \exp \lambda_{ii} (\mu_k - t_{k,i}) g_{ii} \quad (32)$$

and

$$\dot{x}_{kj}(\mu_k) = -\omega (\sin \omega \mu_k g_{kj} - \cos \omega \mu_k h_{kj}) + \sum_{i=1}^k m_{ii} \lambda_{ii} \exp \lambda_{ii} (\mu_k - t_{k,i}) g_{ii} \quad (33)$$

In equations (32) and (33):

$g_{kj}, h_{kj}, d_{kj}$  -- row element No.  $j$  of vectors  $\underline{g}_k, \underline{h}_k$  and  $\underline{d}_k$  respectively  
 $g_{ii}$  -- row element No.  $i$  of  $\underline{q}_k$   
 $m_{ii}, \lambda_{ii}$  -- element No.  $j$  and element No.  $ii$  of  $[M_k]$  and  $[\Lambda_k]$  respectively

3. Substitute the results of (32) and (33) into (29) iteratively until convergence, thus obtaining the value of  $\mu$ .

## V. Computer Program

As there is a large volume of calculation to be done, not to mention the complex and lengthy computation processes, it is important to take the following points into consideration when developing the program:

1. Make full use of the symmetry and similarity of network topography. If the state variables are the same as those in Table 1, the subinterval matrixes and vectors will have the following relations:

$$[L_1] = [L_3] = [L_5] = [L_7] = [L_9] = [L_{11}] \quad (34)$$

$$[L_2] = [L_4] = [L_6] = [L_8] = [L_{10}] = [L_{12}] \quad (35)$$

$$[R_1] = [R_3] = [R_5] = [R_7] = [R_9] = [R_{11}] \quad (36)$$

$$[R_2] = [R_4] = [R_6] = [R_8] = [R_{10}] = [R_{12}] \quad (37)$$

$$[A_1] = [A_3] = [A_5] = [A_7] = [A_9] = [A_{11}] \quad (38)$$

$$[A_2] = [A_4] = [A_6] = [A_8] = [A_{10}] = [A_{12}] \quad (39)$$

$$[\Lambda_1] = [\Lambda_3] = [\Lambda_5] = [\Lambda_7] = [\Lambda_9] = [\Lambda_{11}] \quad (40)$$

$$[\Lambda_2] = [\Lambda_4] = [\Lambda_6] = [\Lambda_8] = [\Lambda_{10}] = [\Lambda_{12}] \quad (41)$$

$$\begin{aligned} \underline{d}_1 &= \underline{d}_7, \underline{d}_3 = \underline{d}_9, \underline{d}_5 = \underline{d}_{11}, \\ \underline{d}_2 &= \underline{d}_8, \underline{d}_4 = \underline{d}_{10}, \underline{d}_6 = \underline{d}_{12} \end{aligned} \quad (42)$$

$$\begin{aligned} \underline{g}_1 &= -\underline{g}_7, \underline{g}_3 = -\underline{g}_9, \underline{g}_5 = -\underline{g}_{11}, \\ \underline{g}_2 &= -\underline{g}_8, \underline{g}_4 = -\underline{g}_{10}, \underline{g}_6 = -\underline{g}_{12} \end{aligned} \quad (43)$$

$$\begin{aligned} \underline{h}_1 &= -\underline{h}_7, \underline{h}_3 = -\underline{h}_9, \underline{h}_5 = -\underline{h}_{11}, \\ \underline{h}_2 &= -\underline{h}_8, \underline{h}_4 = -\underline{h}_{10}, \underline{h}_6 = -\underline{h}_{12} \end{aligned} \quad (44)$$

2. Convergence can be accelerated by using the final values of Kth subinterval's state variable and phase changing time as the initial values of the next subinterval (K + 1)th, i.e.,

$$\underline{x}_{k+1}(t_{k+1}, 0) = \underline{x}_k(t_k) \quad (45)$$

$$\mu_{k+1}(0) = \mu_k \quad (46)$$

3. When processing data, first compute  $\underline{g}_k, \underline{h}_k, \underline{d}_k, [\Lambda_k], [M_k]$  and  $[M_k]^{-1}$ , and put into storage for future use. Then, compute  $\underline{q}_k, \mu_k$  and  $\underline{x}_k(t)$ .

4. The IMSL standardized subprogram EIGRF is used for computing characteristic values and characteristic vectors; the standardized subprograms LEQT1F and LEQT1C are used for computing inverse matrixes and solving sets of linear equations.<sup>7</sup>

## VI. Sampling Results of Computation

Following are primary data used in running the program:

1. Synchronous generator:  $L_g = 0.0796$  h;  $R_g = 0.001$  ohms;  
 $E_m = 100\sqrt{2} / \sqrt{3}$  volts;  $a = 2\pi/3$  arcs = 120 KWh.
2. Transformer:  $L_T = 0.0531$  h;  $R_T = 0.0005$  ohms
3. Load:  $L = 0.6986$  h
4. DC current:  $I_d = 0.5$  A
5. Subinterval:  $k = 60$
6. Period:  $T = 5$

Table 2 shows the sampled results of computing the generator currents  $i_1, i_2$ , and  $i_3$ , and phase change angle in the three phase circuit.

Table 2. Sampled Results of Computing Generator Current and Phase Change Angle

No of periods r	No of inter- vals	Phase-change angle (degree)	Generator's three-phase currents (A)		
			$i_1$	$i_2$	$i_3$
1	1	21.3708214	-0.462144927570	0.266152728910	0.195992198660
2	19	25.9866330	-0.457518583379	0.241165213574	0.216353369805
3	25	25.9866330	-0.457523745243	0.241170375378	0.216353369865
4	37	25.9866330	-0.457528908992	0.241175537072	0.216353369926
5	49	25.9866330	-0.457534088641	0.241180698655	0.216353369986



## VII. Conclusion

From the calculation results, it can be seen that the use of state variable equation and linear system theory for describing constantly changing network topologies and solving the corresponding operational parameters of all subintervals is an efficient, fast and economic method for researching the dynamic simulation of DC transmission systems.

The proper selection of state variables in each subinterval, and the full use of the symmetry and similarity of network topology are effective ways of reducing the number of iterative sessions needed for solving characteristic values and characteristic vectors, and thus reduce online time.

With Newton's iterative method, it is possible to accurately pinpoint phase-change angle and phase-change time. Solution of the phase-change subinterval requires only two iterative sessions, and only one session is required for nonphase-change subinterval.

Due to the extremely heavy load of computing work, plus the complex interleaving relations between the variables, most of the computation was performed by the program during the data preparation stage, and the intermediate results were stored for the processing stage. This not only enabled the development of a compact and clearcut structured program which made it easy to identify and correct errors, but also reduced online time.

The scope of the paper is confined to single bridge DC transmission systems. Thus, further research efforts should be put into finding ways of applying this method to dual bridges, or multiple terminal systems, or complex systems with filters or other components connected to their AC and DC sides.

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APPLIED SCIENCES

COMPUTER PROGRAM FOR COMPUTING DISTRIBUTING LINE POWER LOSS

Beijing DIANLI JISHU [ELECTRIC POWER] in Chinese No 7, 5 Jul 83 pp 18-20, 79

[Article by Qiang Rengyu [1730 4356 5940], Nanjing Electric Power School: "BASIC Program for Theoretical Calculation of Distribution Network Line Power Loss"]

[Text] Using the equivalence method, we have successfully developed and debugged a BASIC application program on a DJS-130 computer to compute line losses in 10 KV distribution lines. Since August last year, it has been used on trial basis to compute line losses in some 50 distribution lines in Nanjing, Kunshan Xian, Jurong Xian and Jiangpu Xian, and more than 650 distribution lines in 20 counties and cities in Zhenjiang and Yangzhou Prefectures; the program could adapt to all kinds of tree structured distribution networks. Following is a brief introduction:

1. Network Model and Algorithm

The equivalence line loss computing method was evolved from mean square root power source method. Originally developed by Yu Zhongnian [5713 1813 1628], Zhang Zuomin [1728 0146 3046] and Xue Boxin [5641 0130 2450] of Jiangsu Province Electric Power Bureau, it was presented in a technical paper at an academic symposium organized in 1981 by the Rural Electrification Committee of the China Electrical Engineering Society. Its strongpoints are: uses simple calculation formulas; uses kilowatt-hour metering which is more accurate than current; also computes equivalent resistances of power lines using iterative method, thus giving play to the high speed, highly efficient and accurate computation capabilities of the computer. Its basic formulas are as follows:

1. Computing distribution circuit equivalent resistance

$$R_i = \frac{\sum_{j=1}^{m_i} S_{ei}^2 \cdot r_{ij}}{S_{e\cdot i}^2} \text{ (ohm)}$$

in which  $r_{ij}$  -- resistance (ohms) in line section  $i$ ,  $i = 1, 2, \dots, m_i$ ;  
 $S_{ei}$  -- sum of rated capacities of distribution transformers which supply power via section  $i$  (KVA);  
 $S_{e\cdot i}$  -- rated capacity of the line's general distribution transformer (KVA)

## 2. Computing equivalent resistance of transformer winding

$$R_T = \frac{U_e^2 \cdot 10^3 \cdot \sum_{i=1}^m \Delta P_{di}}{S_{T,1}^2} \text{ (ohm)}$$

in which  $U_e$  -- busbar mean operating voltage (KV);

$\Delta P_{di}$  -- transformer rated copper loss (kW),  $i = 1, 2, \dots, mB$ .

## 3. Computing equivalent power of circuit using kilowatt-hour meter figures

$$P_{jr} = \frac{A_p}{t} \cdot K \text{ (kW)}$$

$$Q_{jr} = \frac{A_R}{t} \cdot K \text{ (kW)}$$

in which  $A_p$  -- active quantity of electricity according to kilowatt-hour meter at outlet (kWh);

$A_R$  -- inactive quantity of electricity according to kilowatt-hour meter at outlet (kWh);

$t$  -- line operating time (hour)

$k$  -- load modification coefficient, related to minimum load ratio

$\alpha$ ; see Table 1 ( $\alpha = \frac{P_{min}}{P_{max}}$ )

Table 1.

$\alpha$	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
$K$	1.094	1.054	1.03	1.017	1.008	1.003	1.0	1.0

## 4. Computing electric energy loss of one line

(1) copper loss  $\Delta A_{rp} = \frac{P_{jr}^2 + Q_{jr}^2}{U_e^2} \cdot R_T \cdot t \cdot 10^{-3} \text{ (kWh)}$

(2) iron loss  $\Delta A_{rr} = \sum_{i=1}^m \Delta P_{di} \cdot t \text{ (kWh)}$

(3) line loss  $\Delta A_L = \frac{P_{jr}^2 + Q_{jr}^2}{U_e^2} \cdot R_L \cdot t \cdot 10^{-3} \text{ (kWh)}$

## 5. Line loss factor

$$\Delta A\% = \frac{\Delta A_{rp} + \Delta A_{rr} + \Delta A_L}{A_p} \cdot 100$$

## 11. Programming

Figure 1 is an overall block analysis program chart. Following is introduction to the designing techniques employed in some of the main sections of the program.





Figure 1.

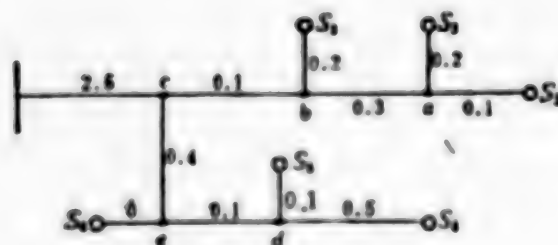


Figure 2.

# 1. Programming routine for line equivalent resistance computation

Example: Line L in Figure 2

In Figure 2, the capacities of the transformers are  $S_1, S_2, \dots, S_k$  (KVA). The nodal points on the line are a, b, c, d, e; the resistances of each line section are also shown in the figure. The nodal points are classified into the following three categories: (1) load nodal points (e.g.,  $S_1, S_2, \dots, S_k$ ), which are directly linked to transformers; (2) nodal points which are not directly connected to transformers (e.g., a, b, d, e); load currents flow out from these points; (3) branches (e.g., nodal point C).

In the program,  $S > 0$  is regarded as load nodal point,  $S = 0$  is treated as nodal point not directly linked to transformer,  $S = -1$  is regarded as branch, and  $S = -2$  is used to indicate returning from branch. If a given branch is further branched, -1, -2 are still used as flags, and the transformer capacity units are accumulated and "stacked" in accordance with "first in first out" rule.

As the size of a "stack" can be represented by a group of figures, it can meet the requirements of any branch of a real distribution line. Since the number of any branch of a real distribution line. Since the number of transformers and nodal points in a line does not follow any pattern,  $S = -3$  is used as an end mark in the program.

The block chart is shown in Figure 3.

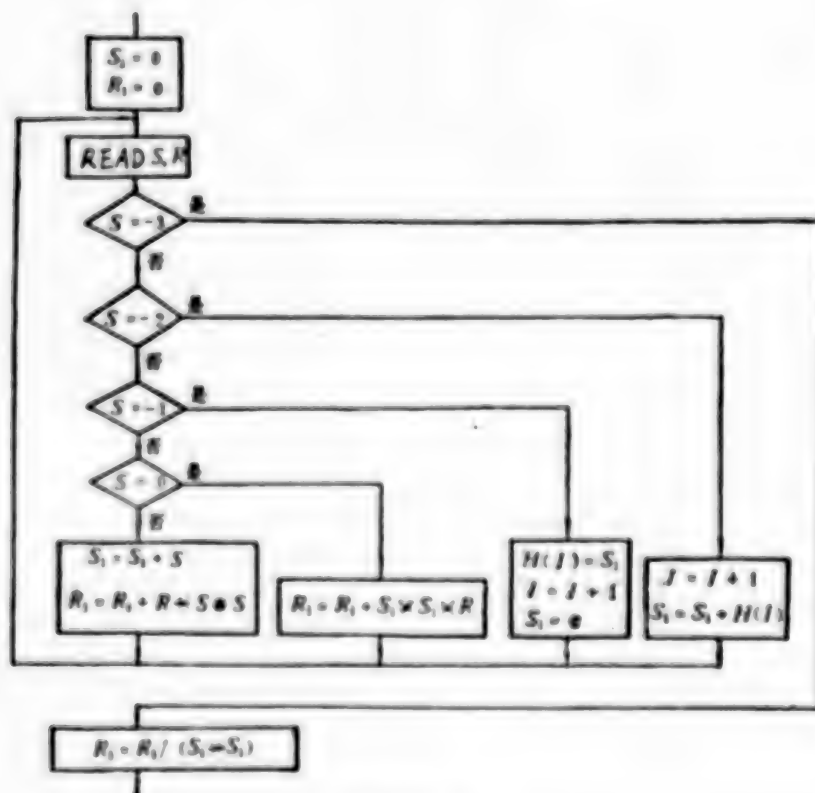


Figure 3.

Following is the program routine of the block flow chart.

```

35 LET R1 = 0
40 LET S1 = 0
50 READ S, R
55 IF S = -3 GOTO 105
60 IF S = -2 GOTO 135
65 IF S = -1 GOTO 120
70 IF S = 0 GOTO 105
80 LET R1 = R1 + R * S * S
90 LET S1 = S1 + S
100 GOTO 50
:
:
:

```

## 2. Program routine for computing transformer equivalent resistance

As the number of transformers does not follow any pattern either,  $m = 0$  is used as an end mark.

Following is a detailed flow chart of the general block analysis chart in Figure 3.

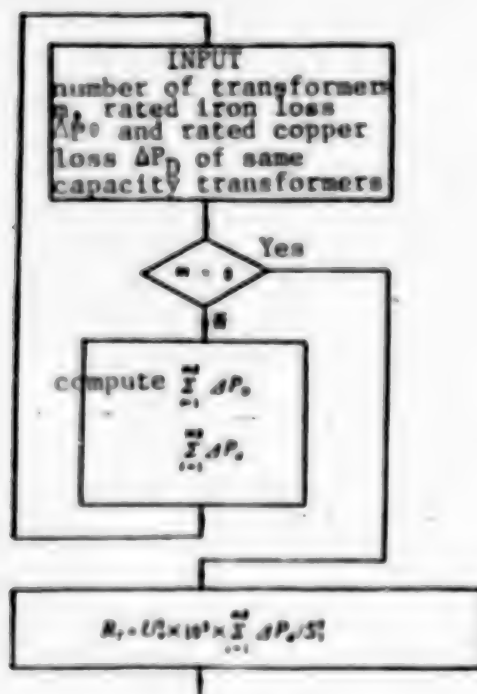


Figure 4.

This flow chart is programmed as follows:

```
300 LET E1=0 (accumulate rated iron loss units)
305 LET D1=0 (accumulate rated copper loss units)
310 READ M, E, D
315 IF M=0 GOTO 345
320 LET E1=E1+E*M
325 LET D1=D1+D*M
340 GOTO 310
345 LET R1=U*U*D1/(1000*(S1+S2))
:
:
```

3. Only monthly active and inactive quantities of electricity and operating time need to be input for computation of monthly line losses. This can be programmed as a loop routine exiting on completion of the 12th month. Annual loss calculation requires accumulation of the monthly results. The flowchart and program statements are omitted here. The general printout formats are designed according to the specific requirements of individual organizations.

### III. Error Analysis

The validity of computation results depends chiefly on two factors: One, proper gathering of primary data and credibility of the metering devices; two, errorless data card punching and inputting into the mainframe. To correct possible data input errors, the program must print out intermediate results for double checking by the user. There is a small error-checking routine to execute a dynamic stop whenever any of the transformers or resistance sections are missing, and resume operation after the programmer corrects the error.

To simplify computation, the equivalence method was programmed on the assumption that all the nodal points had equal voltages, all load power factors were identical, and the load distribution was in direct ratio with the rated capacities of transformers at various load nodal points. When the line primary data failed to meet the conditions, the computation error was great, especially when the ratio  $\alpha$  between minimum load and maximum load was less than 0.3 and the error exceeded as much as 17 percent. Thus, before computing the theoretical line losses of all the distribution lines of 20 counties and cities, we had asked the local technicians to personally inspect the generator rooms and correct any problems encountered. As a consequence, fairly satisfactory results were achieved by the production organizations who computed some 650 lines. Following is a comparative analysis of the experimental computation results of 50 distribution lines.

1. The Huadong Electric Power Management Bureau organized six power supply bureaus of three provinces and one city to use different methods in computing the line losses of Nanjing City Huaihai Line; the results were basically the same. See Table 2 for specific figures.

Table 2.

Computation method	Copper loss (percent)	Iron loss (percent)	Line loss (percent)	Total loss (percent)
Loss factor method (Nanjing Bureau)	0.51	1.94	1.63	4.08
Current drop ratio method (Jiaxing Bureau)	0.76	1.935	1.71	4.405
Node equivalence method (Shanghai Bureau)	0.896	1.935	1.666	4.5
Current equivalence (Hefei Bureau)	0.687	1.94	1.6	4.22
Current/resistance equivalence method (Wuhu Bureau)	0.759	1.935	1.659	4.35
Equivalence method (Zhenjiang Bureau)	0.63	1.94	1.66	4.23
Computer	0.631	1.935	1.68	4.25

2. With the mean square root current method, the line loss rate of Kunshum Xian's Lujia Line was computed at 5.2 percent; with the computer equivalence method, the loss rate was computed at 5.5 percent.

3. In Jiangpu Xian, the average line loss was 6.98 percent for 1 month dating from 15 May to 15 June last year. Two of the thirty-three 10 KV lines incurred more than 10 percent line losses, and plans have already been made to improve Nannung Line which carries the heavier load. Theoretical calculation can reflect the economic operation levels of the lines, i.e., the results of theoretical computation become fairly accurate if the power supply sector is well managed, there are minimal transmission losses, and the electricity is properly metered.

#### IV. Conclusion

1. The program uses simple algorithm and errors are within engineering tolerance range. The BASIC program is conversational, easy to operate, and can be readily popularized in productive applications.

Before getting online, it is necessary to prepare the following information and data: (1) nodal line charts showing the resistance of each line section, and the transformer capacity at each distribution point; (2) number of transformers which have same capacities as well as their rated parameters  $\Delta P_0$  and  $\Delta P_d$ ; (3) monthly operational hours, active/inactive quantities of electricity;



- (4) mean operational voltage and load modification coefficient K of bus bar;
- (5) if there are special transformers, it is necessary to include the number of special transformers of varying capacities as well as their active/inactive quantities of electricity.

The preceding data can be input into the computer interactively or through DATA statements. Line losses can be monthly or annual. Besides single line job runs, the program can also process multiple lines data at the same time, and output separate reports for each individual line. The reports can be printed in Chinese phonetic letters or commonly used symbols. Vital intermediate results can also be printed out for the user to check on the accuracy of computation.

2. Using the computer to compute theoretical line losses is much more efficient than manual calculation. In 1979, 10-odd school graduates spent 4 weeks computing the line losses of Jiangpu Xian. With the computer, it took 16 hours for 1 operator on 1 machine to compute the line losses of 33 distribution lines (the actual online time was only a couple of hours, and the rest of the time spent on data preparation). Moreover, when massive data is involved, computational errors are bound to occur in manual calculations, whereas computers can avoid such errors.

3. In the State Council's Second Directive on Energy Conservation, it is stipulated that "the line losses in rural power supply lines should be reduced to below 12 percent." Out of the 651 lines of 20 counties which were computed, the line losses of 497 lines were within the quota, accounting for 76 percent; and 154 lines failed to meet the regulations, accounting for 24 percent [should be 24 percent]. The high line losses are attributed to the following factors: (1) excessively long power supply radii--generally more than 15 km, or the use of lines with excessively small cross sections; (2) drastic iron losses during empty load periods; and (3) excessively low power factor.

4. The results of line loss theoretical computation are of practical importance to the power supply sector's planning and management operations. It can provide scientific bases for formulating line loss quotas and implementing distributed line/voltage accounting. It can also provide theoretical data for the technical improvement of distribution lines. For example, last year the line loss of Jurong Xian's Laoji North Line amounted to 21.95 percent, which included 0.62 percent copper loss, 2.52 percent iron loss, and 13.81 percent circuit loss. One major factor causing the drastic line loss was the excessive power supply distance, i.e., the bus bar was almost 20 km long, and the branch line 80 km. This year, preliminary improvements have been made: the line is divided into two supply lines; if the annual rate of power supply remains constant, preliminary estimates indicate that it is possible to conserve 190,000 kwh of electricity. In Yangzhou Prefecture, the Hanjiang Xian Power Supply Bureau computed theoretical line losses and came up with the following results: prior to improvements, the line losses of three lines exceeded 12 percent; following improvements, they all dropped below 12 percent, thus conserving 760,000 kwh of electricity per year.

LIFE SCIENCES

SURVEY OF 2141 WOMEN USING INTRAUTERINE DEVICES IN RURAL AREAS

Shanghai SHENGZHI YU BIYUN [REPRODUCTION AND CONTRACEPTION] in Chinese  
No 4, Nov 84 pp 55-56

[Article by Lo Xinmei [7482 0207 1188], Hangzhou Department of Health,  
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[Text] The factors contributing to dislodgement of intrauterine devices (IUD) and subsequent contraceptive or IUD pregnancy are numerous. According to the domestic literature as reported by Wang Jianguang [3769 1367 0342] et al, the chief causes of IUD dislodgement and IUD pregnancy and improper fit and placement technique which still has problems [1]. They have suggested that pelvic measurements should be taken before IUD insertion. After analyzing the placement of IUD's in 70 cases of IUD pregnancy, Li Jingzhi [2621 2417 0037] et al recognized the chief cause of IUD pregnancy to be a downward displacement of the device [2]. These facts fully explain the importance of scientific placement and proper placement technique. At present, the contraceptive use of IUD's is fairly widespread among rural women of childbearing age. These women, particularly those living in the mountainous hill areas, engage in more strenuous physical labor, and understanding their contraceptive-use needs is significant to improving contraception planning in this area. Toward this end, during March and April of 1983, we conducted a retroactive study of 14,739 women of childbearing age under 49 year old in three communes of Yuhang County in the rural flatlands, and in two communes of Tonglu County in the rural hill areas. The results are noted below.

A. On Use of Intrauterine Devices (IUD)

Among the 14,739 women of childbearing age under 49 years old in the five communes described above, 2141 used contraceptive devices, at a rate of 14.53% (99.9% of them using the stainless steel single loop). Among the 5053 childbearing women from the hill regions, 1438 used contraceptive devices, at a rate of 28.46%. Of 9686 women from the flatland plains, 703 used contraceptive devices, at a rate of 7.26%. This illustrates the difficulties encountered in the more mountainous rural hill areas where transportation and adequate medical supplies are problems, and use of contraceptive devices is more widespread there than in the rural flatlands.

Among the 2141 cases where contraceptive devices were used, failure was noted in 361 cases, at a rate of 16.86%. IUD pregnancy was noted in 87 cases, at a rate of 4.06%, a finding basically approximating the report from Sechuan Province [3]. Device dislodgement was noted in 273 cases, at a rate of 12.75%. Extrauterine pregnancy was noted in one case, at a rate of 0.047%.

## B. IUD Pregnancy

1. Relationship with the region or locality. For results of the relationship between IUD pregnancy and the region or locality, see Table 1.

The results from Table 1 have been subjected to  $\chi^2$  examination, with no marked difference in outcome ( $P > 0.05$ ).

Table 1. Distribution of IUD Pregnancies by Region.

Total No. IUD Users	Hill Region			Flatlands		
	IUD Users	IUD Pregnancy		IUD Users	IUD Pregnancy	
		No.	%		No.	%
2141	1438	200	13.90	703	73	10.38

2. Relationship with duration of IUD placement. IUD pregnancies generally take place during the first two years after the device has been inserted, particularly during the first year. See Table 2.

Table 2. Relationship of IUD Pregnancy and Duration of IUD Placement.

		Duration of IUD Placement (yr)							Total
		<0	0.5~1	1~2	2~3	4~	10~		
Flat-lands	IUD (No.)	5	11	13	2	—	1	32	
	Pregnancy (%)	15.63	34.38	40.63	6.25	—	3.13	100.0	
Hill Regions	IUD (No.)	22	16	13	3	1	—	55	
	Pregnancy (%)	40.00	29.09	23.64	5.45	1.82	—	100.0	
Grand Total	IUD (No.)	27	27	26	5	1	1	87	
	Pregnancy (%)	31.03	31.11	29.89	5.75	1.15	1.15	100.0	

LIFE SCIENCES

INTRODUCTION TO HUMAN REPRODUCTION PROGRAM OF WHO

Shanghai SHENGZHI YU BIYUN [REPRODUCTION AND CONTRACEPTIONS] in Chinese  
No 4, Nov 84 p 33

[Article translated and edited by Yang Peilin [2799 0160 3829]]

[Text] I. Introduction

In 1966, the World Health Organization (WHO) established an Office of Human Reproduction in its Medical Research Section to coordinate related scientific research on this topic. Following developments in human reproduction research and family planning or planned parenthood, this office was expanded in 1972 to become the present day Human Reproduction Program (HRP). Under the direct leadership of the deputy secretary, with its office in the World Health Organization in Geneva, the program concentrates on research and development of human reproduction studies and specialist training in these areas.

The purpose of the special program is to emphasize the importance of reproduction research in world development today, and to open up economic resources. The budget of nonprogram agencies of WHO are channeled from headquarters, but special programs can raise funds independently from various nations. Take 1983 as an example. Headquarters only provided \$364,100 to HRP, but HRP was able on its own, to raise a sum 30 times over this figure to reach \$12,700,000 (of this, \$3,220,000 came from Sweden, \$2,160,000 from Great Britain, \$2 million from the United Nations Activities Fund, almost \$1.8 million from Norway, and \$50,000 from China, considered as a developing country).

At present, HRP has 37 persons on its staff (including seven specialists). Under it are three committees: the advisory committee, the research and evaluation committee (including the toxicology evaluation group), and the intensive research committee. Beginning in 1966, the work of the HRP was conducted under the direction of Dr. Alexander Kessler [?], for 18 years. Beginning in 1 July 1984, Jose Barzelatto (originally a senior official in the Tropical Disease Program) assumed the directorship.

The general direction of HRP's work in its present phase is to promote and coordinate parenthood [family] planning studies on the international level through the following four activities to improve the population



health of developing countries: (1) providing up-to-date planned reproduction techniques to health agencies on the grass-roots level on a continuing basis; (2) evaluating the safety of contraceptive drugs and devices presently used; (3) designing and testing new contraceptive techniques; and (4) research into the prevention and treatment of infertility. Through its cooperation with different countries by treatment of infertility. Through its cooperation with different countries by providing personnel and specialist training and material resources, the HRP will be helping developing nations to raise their own scientific research capability.

## II. Some Recent HRP Statistics (for 1983 mainly)

1. Among the 74 nations affiliated with the HRP, 44 are developing countries.
2. Research with HRP participation now covers 600 studies.
3. A total of 160 collaborating research centers have been established.
4. Scholarships have been provided to 120 individuals from 25 countries.
5. A laboratory standardization plan has been adopted by 164 units.
6. A total of 150 scientists representing 46 countries have participated in evaluation of HRP policies and its research studies.
7. The budget proposed for 1983 was \$173 million US.

## III. HRP Collaboration With China

Because of China's emphasis on planned reproduction research and its joint efforts with the HRP, the collaborative projects engaged in by both are increasing. As the result, the HRP has specially designated Dr Frank Weber [?] to specially oversee cooperative activities with China. Up to the present, the HRP has helped fund institutes of planned parenthood research in Shanghai, Nanjing, Wuhan and Hangzhou, and the Population Activities Fund has helped fund three in Beijing, Tianjin and Chengdu (the collaborating work in the latter three is delegated to the HRP). The total amount of funding is over \$8 million US. In addition, fellowships have been provided to more than 100 Chinese scholars to go abroad for refresher courses and study visits.

The results of bilateral collaboration in 1983 are noted in the following partial listing:

1. Clinical studies, particularly those on the intrauterine device and the diaphragm done at multicenters, were well conducted and completed ahead of program schedule.



3. Relationship with age. The incidence of IUD pregnancy decreases with an increase in age. See Table 3 for results.

Table 3. Relationship of IUD Placement and Age.

Age (in years)	20~	25~	30~	>35	Total
No. IUD Users	125	934	711	570	2141
IUD Pregnancy (Cases)	10	55	17	5	87
IUD Pregnancy (%)	7.94	5.89	3.33	0.88	4.06

4. Relationship with parity. As noted in Table 4, the incidence of IUD pregnancy decreases with an increase in parity, that is, an increase in the number of children already borne.

Table 4. Relationship of IUD Pregnancy and Parity.

Parity	No. IUD Users (Cases)	IUD Pregnancy	
		No. Cases	(%)
0	14	1	7.14
1	927	52	5.60
2	705	25	3.55
3	263	4	1.52
4	141	1	0.70
5	58	1	1.72
5	33	3	9.09
Total	2141	87	4.06

### C. IUD Dislodgement

1. Relationship with the region or locality. For results of the relationship between IUD dislodgement and the region or locality, see Table 5. Table 5 suggests the dislodgement rate in women from the mountainous hill regions to be higher than that in women from the flatland plains. Statistical treatment of the difference is highly significant ( $P > 0.01$ ). Dislodgement in cases shown in Table 3 is mostly symptomless. Except for a few women discovering the IUD dislodgement during urination, defecation, or menstruation, quite a few women discovered the dislodgement only after becoming pregnant, with 19 cases presenting this evidence on reexamination.

Table 5. Relationship of IUD Dislodgement and Region.

Total No. IUD Users (Cases)	Hill Region			Flatlands		
	IUD Users (Cases)	Dislodgement		IUD Users (Cases)	Dislodgement	
		No.	%		No.	%
2141	1418	31	1.92	723	33	4.58

2. Relationship with age. The incidence of IUD dislodgement decreases with an increase in age. See Table 6 for results.

3. Relationship with parity. The incidence of IUD dislodgement decreases with an increase in parity. For results, see Table 7.

#### D. Discussion

1. The results of this survey show that more women from the mountainous hill regions use the IUD as a contraceptive measure, as compared to those from the flatland plains. This explains that the effectiveness, simplicity, safety, and reversibility of the IUD are conducive to its acceptance by the women. But it also underscores the fact that the mountainous hill regions encounter problems such as inadequate transportation facilities and insufficient supplies of contraceptive drugs and other devices, which make it easier for the IUD to be accepted.

Table 6. Relationship of IUD Dislodgement and Age.

Age (yrs)	20~	25~	30~	35~	40~	>45	Total
No. IUD Users	126	934	511	225	188	157	2141
IUD (No.)	40	164	50	9	5	5	273
Dislodgement (%)	31.75	17.56	9.78	4.00	2.66	3.18	12.75

Table 7. Relationship of IUD Dislodgement and Parity

Parity	IUD users (Cases)	Dislodgement	
		Cases	(%)
0	44	147	13.41
1	100	79	9.89
2	76.1	27	6.19
3	141	13	3.68
4	18	6	3.31
>5	13	2	2.27
	2141	273	12.75

2. The IUD dislodgement rate among women from the mountainous hill regions is higher than that in women from the flatland plains. This may be related to the fact that women in the hill regions do more mountain climbing and engage in more strenuous physical labor. Because of greater use of abdominal muscles involved in mountain climbing which generates greater abdominal pressure, the uterus contracts more, leading to IUD displacement and subsequent dislodgement. For this reason, any new IUD being developed should consider this shortcoming, and one suited for use by women living in the mountainous hill regions should be designed. At the same time, followup and reexamination of these women should be intensified to lower the dislodgement rate.

3. IUD pregnancy and IUD dislodgement are related to age and parity, their incidence decreasing with an increase in the women's age and frequency [of pregnancy]. This may be due to the fact that the uterus in younger women who have undergone fewer pregnancies is more sensitive to any foreign substance, and its contractions are stronger, thereby leading to easy shifting of the IUD downward, subsequent device dislodgement, and finally IUD pregnancy.

The incidence of IUD dislodgement and pregnancy is highest during the first two years of IUD use. For this reason, intensive followup is necessary.

4. The results of this survey show an IUD usage rate of 14.53% and an IUD dislodgement rate of 12.75%. According to this premise, of 816,606 women of childbearing age in the Hangzhou area in 1982, 118,574 are using IUD's, of whom 15,118 experience IUD dislodgement. The possibility of contraceptive failure is extremely high, the need to improve IUD design and insertion technique is very urgent, and the followup of IUD users must be greatly strengthened.

This survey is made possible through the collaboration of the 11 agencies for planned parenthood [family planning] in Fuzhou and Ningbo [municipalities] of Zhejiang Province, and Shaoxing, Dongta, and Shaoxing within the municipality of Hangzhou. Because "life chart questionnaires" were not used during the design-planning stage, the data presented here is for reference use only.

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2. Li Jingzhi [2621 2417 0037] et al. 1981. SHENGZHI YU BIVUN [REPRODUCTION AND CONTRACEPTION] (3):32.
3. Guo Quanqing [6753 3123 8095], 1981. SHENGZHI YU BIVUN [REPRODUCTION AND CONTRACEPTION] (1):3.

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2. Studies comparing the intrauterine device usage in China and those done abroad showed the native stainless steel IUDs to be well accepted and well tolerated readily, though it caused less bleeding. As a result, an important feature of the Chinese stainless steel IUDs, such as the Huhua IUD, is being produced.

3. Followup results on the IUDs (copper IUDs) showed that in 1979 showed its acceptance by Chinese women, thus refuting the misconception that foreign contraceptive devices are not suitable for Chinese women.

4. Preparations (including training of personnel) for a study on the relationship between vasectomy and cardiovascular disease in men were completed in May 1981. Data collection for the experimental phase was also completed the same year, and results of the experiment suggest vasectomy poses no ill effects. The actual study was begun in November 1981.

5. Interesting data have been collected from studies on biological indicators in male hormones and semen. Further studies on the restoration of reproductive capability in the male after gossypol use show no restoration in some subjects.

6. Five of six new gossypol derivatives synthesized by chemists in Nanjing have been turned over to the HRP for determinative analysis and biological assay. At present, two of the derivatives have been found to be inferior to gossypol in effectiveness; tests on the other three are still ongoing.

7. The two research institutes in Nanjing and Beijing are continuing to explore the mechanism of gossypol action, and the problem of side effects that is still resolved.

8. The first phase of collaborative studies on medicinal plants with contraceptive properties has been going on smoothly (in Shanghai, 16 plant types have been collected, 17 types of extracts prepared, and 17 tested without any positive sampling to date; in Wuhan, 13 plant types have been collected, 17 types of extracts prepared, and 5 tested with positive findings in 2).

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EMERGENCY TREATMENT OF MULTIPLE INJURIES

Beijing JIEFANGJUN YIXUE ZAZHI [MEDICAL JOURNAL OF CHINESE PEOPLE'S LIBERATION ARMY] in Chinese No 6, 20 Dec 84 pp 464-467

[Article by Hua Jide [5478 4480 1795], First Hospital of the Second College of Military Surgeons]

[Text] Traumatic injuries can occur in individual organs or in individual systems, while multiple injuries usually involve trauma to many systems and many organ tissue structures at the same time. Such injuries can cause a breakdown in the body's physiologic-anatomic system, the most important of which is damage to, or hemorrhage in, multiple vital organs, that leads rapidly to death. The effect of multiple injuries on the human body is much more serious than the sum total of damage to individual organs. The treatment of multiple injuries is administration of prompt lifesaving measures to restore the structural integrity and full physiological function of the damaged tissues and organs.

In the past 20 some years, because of greater mechanization in transportation conveyances, the incidence of multiple injuries has shown a corresponding increase. Weapons improvements have increased killing power which in turn lead to an increase of multiple injuries among battle injuries. Among casualties from the Korean War (1950-53), 4.8% of them were multiple injuries; of those from China's war of self defense against Vietnam (1979), 16.28% were multiple injuries. Since then, the treatment of multiple injuries has made great progress, with great improvements in emergency care and triage management, and great strides in surgical technique refinement and mastery.

Progress in Management and Organization

1. Wide public understanding and demand that the injured must be rapidly moved to larger and better medical facilities equipped with the proper personnel trained in trauma surgery.
2. A good and efficient emergency care system. Some countries divide the whole nation into so many emergency zones where tight organization, quick transport and emergency measures are in place, with well-equipped ambulances, evacuation helicopters and anti-shock units. In some cases,

direct instructions from the trauma center are implemented for the immediate care of the injured. Because of the emergency nature of the injuries given the injured before admission to the hospital, many more of the injured arrived in the emergency room of the hospital at 20:00.

3. Establishment of specialized trauma centers, emergency hospitals or emergency surgery hospitals. Large hospitals are staffed with physicians trained in trauma care or trauma surgery, with a trauma emergency care system and good specialized personnel in place. Now, surgeons are beginning to recognize the important role of immediate emergency care in later care. While airway obstruction and hemorrhage are still the direct causes of early death in the injured, the main causes of death in the later stages are infection, septicemia, and functional failure in numerous organs. The focal point in early emergency care is restoration of airway patency, hemorrhage arrest, and measures to prevent infection and organ function failure later on.

4. Changing the prevailing 20-year-old concept that multiple injuries are treated individually according to clinical speciality—an approach still used by most hospitals in China today. Coordination of care is frequently lacking, with adverse effects for the injured during the early and late stages of treatment. This specialty approach to emergency care is gradually being abandoned by many progressive nations today, and active efforts are made to establish a total and comprehensive approach to treatment that recognizes the relationship between the injuries and the various therapies involved. Multiple injuries have forced people to look for a new and even more comprehensive specialty. As the result, in countries such as the United States, the German Democratic Republic, the USSR etc., multiple injuries are treated mostly by general surgeons or trauma surgeons. Some authorities consider the complexity of clinical manifestations in multiple injuries as especially important for the training of medical care personnel. For this reason, trauma surgery requires even stricter training, for a trauma specialist must master techniques of general surgery, orthopedics and vascular surgery, and understand enough of thoracic surgery, neurosurgery and hand surgery to at least perform emergency surgery in these fields. Only on the basis of such multifaceted training can one understand the cause and effect of multiple injuries and their synergistic effects.

#### Vital Sign Evaluation and Emergency Resuscitation in Multiple Injuries

When a surgeon sees large numbers of the injured coming in at once, his first priority is to determine the presence of vital signs in each multiple-injury patient, and assign priority by what is known as triage. At all times, in peacetime or war, this triage sorter must be experienced and knowledgeable, to understand the situation of each injured individual, and be able to direct limited manpower and material resources to save those seriously injured with the greatest chance of survival. At present, those with extensive chest injuries and confirmed cessation of heartbeat and respiration for over 10 minutes are considered to have no chance of recovery. But great care must be exercised before further first aid measures are given up.

Actually, diagnosis and treatment of hemorrhage is the first step in the management of multiple injuries. It is the only one which can be done immediately and which can be done by anyone. The evaluation of the injured's condition is made after the hemorrhage is controlled and the patient is stabilized.

The first step in resuscitation of the injured is to secure the airway, particularly in those with facial trauma. In cases of jaw, facial and neck injuries, or in those who are unconscious, requires clearing the respiratory passage of obstructions and providing oxygen through a mask or an inserted tracheal tube. In a few cases with neck injuries it is impossible to insert a tracheal tube. If necessary, a tracheostomy or a cricothyroidotomy should be performed.

Next is evaluation of cardiovascular function. Circulation failure in patients with multiple injuries is due mostly to an inadequate blood volume which results in a drop in blood pressure. Very few are the result of inadequate pumping action by the heart. For this reason, compensating the blood volume is the important measure for restoring the blood circulation. Emergency fluid supplements should be introduced via an upper extremity vein or the external carotid vein. The basic measure consists of withdrawing blood for crossmatching, after which fluid therapy should be started right away, with clear fluids (physiologic saline, isotonic salt solutions) through several large veins. The importance of blood volume restoration in first aid for multiple injuries is second only to correction of anoxia. For the injured suffering from severe shock, the central venous pressure should be determined immediately after the intravenous infusion has been started. If feasible, a floating catheter should be used to monitor the pulmonary arterial wedge pressure, so as to assess left ventricular function.

Pumping failure of the heart in the wounded with multiple injuries can also induce a blood pressure drop, the obvious sign being a marked dilatation of the carotid veins. A rise in the central venous pressure may occur in myocardial infarction resulting from coronary artery occlusion, injury to the heart, pericardial obstruction, or tension pneumothorax. Cardiac failure, such as myocardial damage resulting directly from coronary thrombosis, is seen sometimes in the middle-aged driver whose chest sustains injury when his vehicle goes out of control, and cardiogenic shock follows the myocardial infarction.

First aid diagnosis of typical pericardial obstruction relies chiefly on the patient's medical history and clinical manifestations. There is a history of crushing chest wounds or puncture wounds, and physical examination on admission shows no obvious internal bleeding but the patient exhibits tachycardia and a low blood pressure of unknown cause. Other symptoms are pallor and coldness in the upper and lower extremities, and marked dilatation of the carotid veins. The central venous pressure is high, and a chest X-ray will show an enlarged heart, though it is not possible to X-ray the patient when his condition is critical and he cannot be moved. Diagnosis is confirmed when pericardial

puncture can withdraw coagulated blood. Withdrawing as much of the accumulated blood as possible by percutaneous puncture will result in an improvement in clinical symptoms. If the pulsatile character of blood coagulation reappears shortly after percutaneous puncture, emergency rib resection must be performed through the fourth and fifth ribs, away from the thorax and the pericardial sac which is opened for removal of accumulated blood and clots. If the wound in the wall of the heart continues to bleed, digital pressure should be applied and the bleeding point sutured. Usually, one or two sutured orifices will suffice for a small puncture wound. However, if the clinical symptoms show marked improvement after the initial percutaneous puncture, emergency chest surgery should be avoided and the patient should be admitted and closely observed.

In tension pneumothorax, because a change has occurred in the intra-thorax pressure, the mediastinum is deflected toward the healthy side and the return flow in the vena cava is reduced, thereby creating a blood flow stasis leading to a drop in the myocardial flow. The lung on the injured side is collapsed, breath sounds disappear, tympany is noted on percussion, and the trachea is deflected toward the healthy side. On the basis of these clinical manifestations, diagnosis is confirmed, and emergency thoracic puncture via the second anterior intercostal space should be performed immediately to withdraw the air, followed by a tube thoracostomy and water-sealed drainage of air, and decompression. As the patient's condition is critical, it is not necessary to do a chest X-ray.

#### Diagnosis of Multiple Injuries and Emergency First Aid Treatment

While correcting the anoxia, a systematic examination of the whole body should be done at the same time, beginning with the head, chest, abdomen and then, the extremities. The important thing is not to overlook any internal injury, for delayed diagnosis and treatment of such injuries can quickly evolve into a life-threatening situation. Careful examination (by sight and touch) must be done on each body part, particularly seriously injured internal organs or fractures under skin covered by abrasions and bruises. Not to be overlooked also, are injuries to the rectum and vagina. The trend at present is for quick diagnosis and treatment and prompt management using simple and quick procedures to replace complex techniques.

1. Head injuries. The incidence of head injuries is second only to those involving the extremities. Generally speaking, those with head injuries who can be saved are not in as urgent a category as those with serious chest or abdominal bleeding. The deep coma seen in head injury cases is usually indicative of extensive brain injury to the basal ganglion or brain stem, where there is a progressive post-injury impairment of consciousness which is a manifestation of an acute rise in intracranial pressure. When first aid is given such cranio-cerebral injury cases, the nature and extent of the injury must first be determined: whether or not there is pressure on the brain and other



dangerous conditions, the external nature of wound complications affecting other body parts also is determined the priority of treatment. The CT scanning is largely not satisfactory. Something is of significant diagnostic value. For acute intracranial hemorrhage and foreign body penetration, the routine debriding debridement of the wound, emergency debridement of the skull may be done to remove the hematomas, control bleeding, close the wound, and reduce intracranial pressure. However, the patient should be removed to the operating room for those procedures to be done. For firearm injuries to the head and the value made of efforts to remove it possible, with complete debridement of wounds.

2. Neck injuries. In closed injuries to the neck, attention must first be given to the possibility of fracture or dislocation of the cervical vertebrae, high paraplegia resulting from damage to the cervical spinal cord, subcutaneous crepitus of the neck, extreme dilation of the carotid veins, and displacement of the trachea. The most serious complication of neck puncture wounds is bleeding from blood vessel damage where a bullet fragment or other foreign body penetrates the soft tissue and blood vessels in the neck. Removal of the foreign body should not be undertaken lightly during emergency treatment. It must be done with surgical preparation for handling excessive bleeding, as blood may gush forth when the wound is stretched and dilated for careful removal of the foreign body, and repair of blood vessels can be done immediately to arrest the bleeding. If this injury is compounded by trauma to the trachea and esophagus, breathing difficulties swallowing obstruction, and subcutaneous crepitus will be noted. Treatment of choice for neck puncture wounds tends toward selective exploration. Timing of surgery is based on the time the injury was sustained, location of wound, direction of the bullet's path, and changes in vital signs. In presence of continuous bleeding or progressive hematoma formation caused by blood vessel damage, or esophageal injury with swallowing difficulties and hematemesis, or trauma to trachea accompanied by respiratory difficulties, or projectile wounds where the foreign body is embedded in the blood vessel, trachea or esophagus, emergency surgery should be performed immediately to arrest the hemorrhage, extract the foreign body, and repair the esophagus and the trachea.

3. Chest injuries. In crushing injuries to the chest, the first step is to inspect the symmetry of the chest, the presence of difficult breathing, and movement of the chest wall in respiration. Not only does the staggering frame chest caused by multiple rib fractures present with a disturbance in physiologic function, it is frequently accompanied by serious pulmonary trauma. In an acute emergency situation, percussion of the chest wall is more practical for determining the rib fracture site with greater accuracy than an X-ray examination. After the diagnosis has been made, traction fixation of the chest wall should be performed quickly. Percussion and listening with the stethoscope can generally assess the accumulated air and blood volume in the chest to determine the presence of pneumothorax, hemothorax, or pneumo-hemothorax. The treatment of tension pneumothorax and progressively serious hemothorax



injury depends on the extent of the injury. In some cases, a closed injury may be the only one, but in others, a closed injury may be associated with a fracture. The degree of injury is determined by the degree of the injury. The degree of injury is determined by the degree of the injury.

e. Abdominal and pelvic injuries. The diagnosis of abdominal injuries depends chiefly on physical examination, particularly on abdominal irrigation. Signs of peritoneal irritation such as guarding, rigidity, reflex pain to the abdomen and tenderness to the abdominal muscles, and the absence of intestinal sounds are the usual signs of internal organ bleeding or rupture. If serious shock reflecting low blood volume is present and the chest shows no obvious signs of trauma, internal bleeding in the abdomen should be considered. Paracentesis is a simple and safe procedure with an over 90% accuracy rate. However, if abdominal internal organ injury is highly suspect but the paracentesis results are negative an incision may be made at midline below the umbilicus for irrigation of the abdominal cavity. We have conducted this procedure on many cases in which paracentesis findings were negative, but once the peritoneum was opened, blood gushed forth to confirm the presence of internal abdominal organ injury. The diagnosis of patients with low blood volume shock should not depend on observation over a long period of time and also timely diagnosis and treatment. The procedure for abdominal irrigation is simple, diagnosis is quick, and no special equipment is required. Not only can this procedure be used on ordinary closed wounds, it can also be used in battle injuries where no abdominal wound is seen, but a projectile wound, where a bullet is suspected to have penetrated the abdomen, is noted.

X-rays made of the abdomen are of definite diagnostic value in locating metal foreign bodies in fractures of the lumbar spine and the pelvis, and the presence of free gas (as shown on the X-ray) can pinpoint the injury as a stomach or intestinal injury. However, this should only be done when the patient is in generally good condition. If the clinical symptoms are obvious, and paracentesis or abdominal irrigation is negative, it is not advisable to move a patient with multiple injuries unnecessarily, but an exploratory laparotomy should be done as soon as possible. B-type ultrasound, abdominal arteriography or CT (computerized tomography) is only used for a few difficult to diagnose cases where the clinical symptoms are not critical and the patient is in reasonably good condition. B-type ultrasound can aid in the diagnosis of sub-perisplenic hematoma.

Among serious injuries, particularly those resulting from automobile accidents or other crushing trauma, the incidence of pelvic fractures is somewhat higher. Basically, a pelvic fracture is easy to detect. It shows up as an abnormal looking pelvis, the pubic bones are joined, the ala of the ilium is painful to the touch, and fracture of the upper femur or neck of the femur is frequently a complication. While a fractured pelvis poses no immediate danger of death, trauma to the

pelvic organs or presence of a post-peritoneal hematoma is easily overlooked. Progressive post-peritoneal bleeding is frequently the cause of death in such injuries. In cases where bleeding, infection, and functional damage result from ruptures in pelvic organs such as the uterus, ovaries, rectum and bladder, their mortality is not only high, their management at a later date is also difficult. Under emergency conditions, a prompt diagnosis should be made, and emergency surgery should be performed.

5. Injuries to the extremities. The most important consideration in the emergency treatment of multiple injuries to the extremities is prompt physical examination to determine the presence of bone fractures and blood vessel injury. Penetration wounds and avulsions of soft tissue are comparatively easy to locate. Neurological injuries are frequently overlooked in the unconscious or in those suffering from serious acute shock. Though this is not important in an emergency situation, such injuries will be uncovered after hospitalization.

Injuries to the extremities will present as noticeable pain and swelling, pain on pressure, and abnormality of the part. For trauma cases who are conscious, a quick examination using axial percussion should be done. Such examination of the wrist can uncover fractures of the radius, ulna, humerus, and clavicle, which may be accurately located by X-ray. If percussion of the ankle area uncovers pain in the tibia, femur and pelvis, X-ray of the painful area will reveal the fracture site as well as the type and severity of the fracture. Such X-ray examination can be done if the overall condition of the patient allows moving the patient. Otherwise, it is more important to attend to internal injuries which first calls for arresting hemorrhage and alleviating shock before X-rays are made. The treatment of fractures can be done after surgery to control bleeding, or even after the condition of the injured has stabilized.

The chief cause of death in the later stages of multiple injuries is septicemia resulting from infection and functional breakdown in several organs. For this reason, thoroughness of the surgery in the early stage, and appropriate antibiotic use before, during and after surgery to prevent infection are very important. Special nursing care after surgery and placement of critically ill patients with multiple injuries in the intensive care unit is a great step forward in recent years in the timely prevention and treatment of post-surgical complications. Concentrated intravenous feedings and performing a jejunostomy for feeding patients with abdominal injuries will help patients build up their resistance. The use of such beneficial treatment measures have raised the survival rate of patients with multiple injuries.

#### Existing Problems in the Management of Multiple Injuries

While great emphasis has been placed in China and abroad on the study of trauma, particularly that associated with serious multiple injuries, several problems have yet to be resolved.

1. Organization and management. Most hospitals in China today are characterized by specialized departments and units: the larger the hospital, the greater the number of specialties, and smaller the scope of each specialty. For example, at the author's hospital, the department of surgery contains nine subspecialties. Treatment of some serious multiple injuries will involve not only surgery, but also ophthalmology, rhinocotolaryngology, stomatology, gynecology, pediatrics, and even internal medicine. While medical care components in China show fairly good cooperation and collaboration, problems frequently arise in the treatment of multiple injuries because of their complexity and difficulty of specialty assignment. This applies in early stage emergency care as well as later followup care. Sometimes an injured person may go through four to five specialties in the process, a procedure which is lacking in continuity and not good for the patient. In some countries there is a trauma surgery specialty, where a group of physicians experienced in trauma surgery assumes care for the injured from time of admission to the hospital through the whole course of treatment, sometimes advising, sometimes monitoring treatment. However, such physicians require very good training.

2. Technical problems. At present, many problems concerned with techniques have yet to be satisfactorily resolved. For example, the mortality rate is still high in massive hemorrhage from the liver resulting from section of the portal vein in serious liver injuries, in massive hemorrhage from post-hepatic laceration of the inferior vena cava, in extensive head injuries, and in acute respiratory arrest syndrome in adults after surgery.

The use of angiography in recent years is an exciting development. Not only can it be used to determine the bleeding site, it can also be used to position a therapeutic plug for arresting the hemorrhage. But the condition of many with multiple injuries prohibit unnecessary moving, and it is difficult to determine if bleeding is only from this type of injury. As the result, it is frequently difficult to resolve the patient's actual problem.

3. Complications. While the lives of many who have sustained multiple injuries may have been saved, many residual complications still pose a prickly problem. Complications such as paraplegia, nerve damage, the loss of anal sphincter control in injuries to the rectum and anus, and urinary tract infection or urinary incontinence remain. As these people frequently want to live normal lives and hope sometimes to engage in normal work activities, many of these complications are still difficult to resolve to make such hopes possible.

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CSO: 4008/187

LIFE SCIENCES

PRC MEDICAL ASSOCIATION MARKS 70TH ANNIVERSARY

OW020920 Beijing XINHUA in English 0858 GMT 2 Jun 85

[Text] Beijing, June 2 (XINHUA)--The 70th anniversary of the founding of the Chinese Medical Association and National Medical Journal of China was marked by a gathering of 300 doctors and specialists here today.

Wu Jieping, president of the Chinese Medical Association introduced the association founded in 1915, as a popular national academic society. Its task, he said, is to promote national and international exchanges, develop friendly cooperation with foreign societies and publish the "National Medical Journal of China" (monthly) to introduce the progress made in Chinese medical science as well as disseminating medical knowledge.

He said, the medical association now has over 80,000 members, 39 societies of different fields of medical science, and a working committee to disseminate medical knowledge. There are also more than 360 branch societies in various provinces and cities, contacting over 4,000,000 medical workers throughout the country and publishing 42 periodicals.

Born in the same time with the medical association, the "National Medical Journal of China" is one of the earliest national journals, dealing with natural science. It played an important part in introducing advanced medical techniques at home and abroad and also in exchanging medical achievements between China and other countries.

Wu Jieping said that in recent years, besides academic activities, the association has done a lot on hepatitis prevention, perinatal medicine, family planning, food hygiene, children's health, autopsy, medical morality education, etc.

Minister of Public Health Cui Yueli, former presidents Qian Xinzong and He Biao were present at the gathering.

CSO: 4010/2000

LIFE SCIENCES

MEDICAL FACILITIES GIVEN BACK ORIGINAL NAMES

OW051312 Beijing XINHUA in English 1240 GMT 5 Jun 85

[Text] Beijing, June 5 (XINHUA)--The 66-year-old Peking Union Medical College (PUMC) and its teaching hospital were given their original names back at a ceremony here today.

The two establishments were opened as the PUMC and PUMC hospital by the Rockefeller Foundation's China medical board in 1919 and 1921 respectively.

They were taken over by the Chinese government in 1951, and the college was renamed twice before being called the Capital Medical College of China in 1979, when it was restored after being suspended during the cultural revolution (1966-1976).

The PUMC hospital was named "Fan Di" (anti-imperialism) in 1967, and then became the "Capital Hospital" after the Sino-U.S. Shanghai communique was published in 1972.

The hospital, which had about 250 beds and could receive nearly 1,000 outpatients a day when it opened, now has 700 beds and can treat 3,000 outpatients daily.

A hospital official said the government planned to spend 130 million yuan in a five-year expansion program beginning next year, which would boost the number of beds to 1,200 by 1990.

At present it has 28 clinical and auxiliary departments, compared with 18 in 1951.

The Chinese Academy of Medical Sciences has established four research centers at the hospital--obstetrics and gynecology, endocrinology, ophthalmology and nuclear medicine.

A center for classification of diseases and a training center dealing with rheumatics are being run by the world health organization in the hospital.

It also has formal cooperative links with medical organizations in Australia, Canada, France, Japan and the United States.



LIFE SCIENCES

BRIEFS

PSYCHOLOGICAL TESTING CENTER OPENS--Beijing, June 6 (XINHUA)--Beijing Teachers' University this afternoon opened China's first psychological testing and advice center. With 40 professors, doctors and experts, it will test and counsel on intelligence, character and occupational aptitude. It will identify gifted and handicapped children and advise on jobs, college majors, marital troubles and mental problems, as well as serving also as a psychological experiment base. There are now psychology courses in all China's 80 teachers' colleges. Psychology departments in four universities have over 400 students. [Text] [Beijing XINHUA in English 1504 GMT 6 Jun 85 OW]

CSO: 4010/2000

ENVIRONMENTAL QUALITY

ENVIRONMENTAL PROTECTION NETWORK ESTABLISHED TO FIGHT PRC POLLUTION

HK070409 Beijing CHINA DAILY in English 7 Jun 85 p 1

[Article by Guo Zhongshi]

[Text] An environmental protection network is being set up throughout the country to combat serious pollution problems.

However, environmental pollution and destruction in Chinese cities have not been brought under control yet and the vicious circle of ecological destruction is yet to be averted, according to Qu Geping, director to the State Environmental Protection Agency.

"We've got a long way to go in our attempt to tame pollution and protect the environment," Qu said at a meeting to commemorate International Environment Day yesterday.

The seriousness of the problem has prompted the government to intensify efforts and take concrete measures to stop the situation from getting worse, he said.

Last year, mayors in more than 70 cities took on the matter themselves and have had some success, he said.

At a public lecture on youth, population and environment on Tuesday, Qu said environmental protection has been made a State policy and that the development of economy and environmental protection must go hand in hand in the country's modernization drive.

By the end of 1984, construction plans had been made for 273 cities--91 percent of the total. In addition, 1,240 county towns had also made their plans, accounting for 61 percent of the total. All these plans include special chapters on environmental protection.

Urban industrial pollution is being tackled in a comprehensive manner by taking such precautions as redistributing industrial layout, harnessing sources of pollution, changing fuels and controlling noise.

Farmers are becoming aware of the reasons for developing agriculture in accordance with the laws of ecology. In 1984 more than 50 eco-agricultural units developed agriculture, forestry, animal husbandry and fisheries that ensure a rational recycling of energy and materials.

Farmers in different parts of the country have been experimenting with new methods since last year's national meeting on ecological agriculture.

Great progress has been made in greening the country, Qu said. Some 6.32 million hectares of forests were created in 1983.

The first phase of the windbreaking forest belt in North China has been effectively completed with the planting of 5,933,000 hectares of trees--erecting a "great green wall" in the desert. He said that the provinces on the Loess Plateau have been planting trees and sowing grass to restore plant cover.

The number of different nature reserves of different kinds including forest, steppe, swamp, beach and island, is growing. At present, there are 262 nature reserves, covering 1.62 percent of the country's land area.

Earlier, Qu said that China must draw a lesson from the effects of industrial pollution in other countries, and import foreign technology and equipment to curb the problem.

"Unless we take immediate measures, we are likely to face the same social problems that plagued Western countries in the 1950s and 60s," he said.

CSO: 4010/2001

ENVIRONMENTAL QUALITY

ADVANCES IN RESEARCH ON MARINE ENVIRONMENT DISCUSSED

Beijing HUANJING KEXUE [ENVIRONMENTAL SCIENCE] in Chinese No 4, 30 Aug 84 pp 67-71

[Article by Wu Baoling, Oceanographic Research Institute of the State Oceanography Bureau, and Li Yongqi, Shandong Oceanography Institute: "Developments in Chinese Research on the Marine Environment"]

[Text] Oceans take up 71 percent of the earth's surface and are an important component of the world. Life started in the ocean; the ocean is a cornucopia; the ocean is intimately bound up with man's efforts toward material and spiritual growth, and without the science of the ocean, man would not be able to achieve results in his exploration of the circulation of materials and of energy on this globe.

The science of the marine environment is one important sector of the environmental science, as it is also a newly rising branch of oceanography. In China the study of the science of marine environment started toward the end of the 1950's, but it was only during the last 6 or 7 years that it actually received serious attention and began its very rapid development.

In 1976, we already wrote an article on the basic studies of the marine environment in China, entitled "Chinese Research Into the Marine Environment," published in the Ocean Publishing Co's "Thirty Years of Chinese Oceanography." Recently, we made a careful study of the almost 300 articles on the marine environment and on related subjects, published by Chinese scholars since 1979 in 17 different periodicals, such as HUANJING KEXUE XUEBAO [JOURNAL OF ENVIRONMENTAL SCIENCE], ZHONGGUO HUANJING KEXUE [CHINESE ENVIRONMENTAL SCIENCE], HAIYANG HUANJING KEXUE [MARINE ENVIRONMENTAL SCIENCE], HAIYANG XUEBAO [JOURNAL OF OCEANOGRAPHY], HAIYANG YU HUZHAO [OCEANS AND LAKES], SHENGTAI XUEBAO [JOURNAL OF ECOLOGY], SHUICHAN XUEBAO [JOURNAL OF MARINE PRODUCTS], SHANDONG HAIYANGXUEYUAN XUEBAO [JOURNAL OF THE SHANDONG COLLEGE OF OCEANOGRAPHY] and HAIYANG KEXUE [OCEANOGRAPHY]. These articles and publications reflect different aspects of the progress made in China during recent years in the study of the marine environment. A review of our past achievements will be of great value as a summary of experiences, as an outlook on future prospects and in the promotion of speedier developments in this field.

## 1. Rapid Expansion of Our Research Contingent

The last few years saw a most gratifying development of our research contingent, as manifested in the following four aspects:

(1) According to rough estimates, over 1,000 persons are currently directly engaged or participating in marine environmental research and teaching in this field, of whom about two-thirds are specialists, having graduated from specialized universities and colleges. Since 1979, up to 400 scholars have published articles in various periodicals, almost 10 percent of whom being personnel with professional titles of high rank.

(2) Scientific research on the marine environment is now no more the topic of serious concern of only the ocean-related entities along the coast. Oil exploration and transportation along our coasts and other industrial and agricultural developments have induced many entities, originally not interested in ocean research, to "move down to the ocean" and start oceanographic research.

(3) The discipline is a replete field of scientific endeavor. Among the specialists currently engaged in the research of the marine environment, we are happy to note that, apart from those who have graduated in such specialized fields as physics, engineering, agriculture and medicine, a small number of specialists in social science research (such as in law and economics) have also begun to join our ranks in recent years. As is well known, the science of the marine environment covers many scientific topics and is very comprehensive in nature. Completion of many of its important tasks requires formation of a joint battlefront by specialists and technical personnel from many different disciplines to work together in full cooperation and unity of purpose. The structural composition has now become more rational than before, a fact that will certainly benefit future progress.

(4) A breakdown of the above-mentioned 400 scholars shows that 98 percent are middle-aged and young scientific and technical personnel. Guided and nurtured by the party, many middle-aged and young scientific and technical personnel have reached maturity in actual practice and are now constituting a precious force for the rapid development of marine environmental science in China.

## 2. Unceasing Thorough Research Achieves a Series of Successes

Judging by the material that has so far been published, this research comprises in substance roughly the following topics: methods and instruments for the testing of various pollutants, investigating the sources and conditions of pollution, the laws of dispersion and dilution of pollutants entering the ocean, the laws governing the formation and drift of pollutants in the ocean and on the ocean floor, absorption and accumulation of pollutants in marine fauna, the biological metabolism and the toxic effects of certain pollutants, the effects of pollutants on the health of the fishing and residential population along the coast, environmental capacity, environmental evaluation, monitoring of marine pollution, regional division of the marine environment and the formulation of laws for the protection of the marine environment.



In the last few years, many scholars have reported on methods for the determination of pollutants in seawater samples. In the use of cold electron absorption to determine mercury content in seawater, improvements in methods were made from various different angles by Qian Wanying [3383 3834 5391] (1978), He Chengshun [0149 2110 7311] (1981) and Xu Kuncan [6079 3540 3503] (1982). Liu Jidi [0491 7139 1717] (1979), Zeng Zhaowen [2582 2507 2429] (1980), Wu Jingyang [0702 2529 7122] (1980, 1982) and Yang Mingquan [2799 2494 0356] (1983) used a method of electron absorption spectral luminosity to determine the content of copper, cadmium, lead, zinc, cobalt, nickel and chromium in seawater, and did so with excellent results. Yu Guohui [0151 0948 6540] (1979), Huang Weiwen [7806 5633 2429] (1980) and Xin Xueyi [6580 1331 3015] (1982) used the method of anode-expelled volt-amperes to determine trace elements in seawater and also achieved excellent results. Wang Shunrong [3769 7311 2837] (1980) reported a method of inorganic gas chromatographic determination of chromium; Qian Xingzhen [6929 2622 3791] (1983) successfully used neutron activation analysis to determine trace elements in seawater. Zheng Shunqin [6774 5293 3830] (1981), Huang Huarui [7806 5478 3843] (1981), Gu Tangxiu [0657 1016 4423] (1981) and Dai Yuncong [2071 0061 1783] (1983) reported using ultraviolet absorption spectral luminosity and infrared absorption spectral luminosity to determine oil pollutants in seawater. The use of fluorescent spectral luminosity under conditions of varying excitation wave lengths is quite effective in distinguishing ship's fuel oil, engine oil and crude oil as pollutants (Xu Jiheng [1776 1015 5683] 1982, 1983). The use of petroleum porphyrin can assist in detecting petroleum pollutants (Sun Chongzhong [1327 1504 1813] 1981, 1983). Apart from using various methods to determine the radioactivity of seawater, bottom sediment and organisms (Li Peiquan [2621 1014 3123] 1982, 1983, Qin Xuexiang [4440 1331 4382] 1983, Xu Mingde [1776 2494 1795] 1981, Zhong Bingnan [6945 3521 0589] 1982, Liu Fayi [0491 4099 5030] 1980), the Ministry of Public Health organized 30 entities for a 3-year investigation of the radioactivity of marine foodstuffs from China's coastal waters, resulting in the 1983 publication of a book, "The Investigation of Radioactivity of Marine Foodstuffs," which gives a detailed introduction to testing methods for 16 radioactive nucleins. The First Research Institute of the State Oceanography Bureau used aerial remote sensing technology to monitor pollution in Jiaozhou Bay. The Beihai branch of the State Oceanography Bureau began in 1983 to use aerial remote sensing technology to monitor ocean pollution. In their opinion the use of multiple sectional chart photography is very effective in monitoring the range of ocean pollution by industrial waste water, oil and industrial waste residue, also in distinguishing the different types of pollutants and in tracing the sources of pollution. To solve problems currently encountered in testing ocean pollution and to ensure the quality of this work, the marine environment subdivision of the ocean affairs group within the State Science and Technology Commission established in 1981, a "Test Control Group for Ocean Environment Protection." To guarantee the quality of investigations and facilitate comparisons of results, the State Oceanography Bureau, in 1979, organized certain relevant entities for the compilation and publication of a set of "Provisional Norms for the Investigation of Ocean Pollution."

The investigation of the sources and the conditions of pollution in the coastal waters is an important item of fundamental research of marine environmental science, which enables an evaluation of the environmental

quality of the ocean areas and which is a prerequisite for launching preventive and protective measures.

The Bohai and the southern regions of the Huanghai are the ocean areas that were investigated the earliest for oceanic pollution, and work in these areas has been carried out uninterruptedly since 1972. The investigations have revealed that parts of the Bohai and Huanghai have suffered pollution from oil and heavy metals. This attracted the attention and concern of the party and the state, so that pollution prevention in the Bohai and Huanghai areas was included as one of the key research topics of the nationwide environmental protection work and also included as a key item of the country's scientific and technological endeavors. In June 1978, an environment monitoring network was set up for the Bohai and Huanghai areas to carry out long-term monitoring, to promptly gain control of any pollution that should develop and to provide data for the control and regulation of pollution of the seas. The investigation of oceanic pollution in the coastal waters of the Donghai was started in 1974. During 1978 to 1979, investigations were carried out jointly by the four provinces (municipalities) of Jiangsu, Shanghai, Zhejiang, Fujian and the Donghai branch of the State Oceanography Bureau as well as of its second and third research institutes, in the area from the mouth of the Chang Jiang to Luoyuan Bay and west of 123 degrees 30 seconds E. The Oceanographic Research Institute of the Chinese Academy of Sciences has also carried out an investigation of the pollution in parts of the Donghai area.

Investigation of the Nanhai area was begun in 1975, and prior to 1978 the investigation primarily concentrated on the ocean outside the mouth of the Zhu Jiang. During 1978 to 1979, three investigations of pollution were carried out by a cooperative pollution investigation group in West Guangdong coastal waters. As of 1980 on, investigation of the pollution of the coastal waters of East Guangdong were also started.

In March 1980, the Marine Environment Protection Institute of the State Oceanography Bureau was entrusted by the Chinese Association for the Study of the Marine Environment and the State Oceanography Bureau with the collection and collation of investigative materials on the sources and conditions of pollution of China's coastal waters (the Chinese territories of Taiwan, Hong Kong and Macao are temporarily omitted), and the main results of this endeavor are as follows:

Results of the investigation of the sources of pollution have revealed that China's nearby coastal waters suffer pollution mainly due to discharge of waste water from coastal industries and from domestic wastes into the ocean. Main pollutants contained in waste water are: petroleum, mercury, cadmium, chromium, lead, zinc, arsenic, phenol, cyanides and organic matter. Furthermore, almost 150,000 tons of organic compounds of chlorine and phosphorus are annually used in agricultural chemicals in the counties along the coast (Shi Ehou [0670 6759 0230] 1982).

The main channels by which waste water from the coastal areas enters the ocean are: carried by rivers, direct discharges by industrial and mining enterprises, discharges from oil fields along the coast, discharges in the

course of port or shipping operations or due to accidents, discharges from offshore oil rigs and atmospheric deposits into the sea.

The investigations have revealed that petroleum is the main pollutant in China's coastal waters and that petroleum pollution is quite serious. The average concentration of petroleum residue dissolved/dispersed in the water is 0.053 mg/l, which exceeds the maximum concentration permitted according to the "water quality norms for fishery" (which stipulate 0.05 mg/l as maximum). Petroleum pollution covers about one-third of the investigated area, the coastal waters close to shore of Donghai and Bohai being most seriously affected. Apart from some parts of the sea close to shore and at the mouth of rivers, pollution by heavy metals is generally light. In the Bohai area, pollution by organic matter is most serious, according to COD calculations, one-fifths of the determined values exceeding the requirements of the "seawater quality norms" for first quality water (less than 3 mg/l). Man-made radioactive pollution of the waters of the Bohai gradually decreased year by year from 1970 on. The total beta radiation of the Bohai seawater in 1981 was about 1.8 microcurie/liter and strontium 90 was about 0.29 microcurie/liter.

In the last 10 years, over 100 comprehensive pollution investigations and surveys were carried out, checking an area of about 400,000 sq km and participated in by almost 5,000 investigation and survey stations, which collected a huge amount of samples of seawater, ocean floor sediment and organisms. The work yielded more than 300,000 pieces of data of various kinds and ascertained to varying degrees the pollution conditions in the various ocean areas, which in turn yielded scientific data useful for the rational distribution of industries and the protection of the marine environment.

Discharge into the ocean of a certain quantity of waste material is permissible because the ocean has the ability for self-purification of many kinds of pollutants. In this respect the vast ocean is a highly valuable natural resource. However, the capacity of the ocean for self-purification is limited. If waste matter is dumped into the ocean without restrictions, it will exceed its capacity for self-purification and is bound to get back with disastrous consequences. There are also large differences in the self-purification capacity between various parts of the ocean due to differing natural conditions. To understand and to properly utilize the self-purification capacity of the different sectors of the ocean is of extremely important significance for industrial and agricultural production in the coastal areas and for the protection and exploitation of the oceans. This is also one of the key objectives in our current research in the science of marine environment.

The self-purification capacity of water is mainly determined by the movement of the seawater, the degree of admixtures and the transport dynamics of the pollutants, also determined by the physical and chemical composition of the pollutants in the water, the chemical processes of their transformation and their biological and precipitation processes. In the last few years, scholars from the Shandong Oceanographic Institute, the Environmental Protection Office of the State Oceanography Bureau, its First Research Institute and from the Oceanographic Institute of the Chinese Academy of Sciences used the method of numerical modeling with great success in a very thorough study of the physical



self-purification capacity of Jiaozhou Bay (Wang Huatong [3769 0553 2717] 1980, Yu Guangyao [0205 0342 5069] 1983, Chen Shijun [7115 2514 0193] 1983), of Jinzhou Bay (Wang Fenghua [3796 7685 5478] 1982), of Bohai Bay (Yu Tianchang [0060 1131 1603] 1982) and of the Bohai (Dou Zhenxing [4535 2182 5281] 1981, 1982); all achieved most gratifying results.

The main movement of pollutants in Jiaozhou Bay is advective, and although in overall perspective Jiaozhou Bay has a strong capacity for the elimination of pollutants, we have to divide the entire area as to its capacity to move the pollutants, according to the Lagrange method of excess flow calculation, into two parts: the two main vortexes south of a line from the mouth of the Haibo He to the mouth of the Daku He with a rather swift Lagrange excess flow of generally several cm per second or a maximum of 10 cm per second; this is an area of very strong self-purification capacity. In the other areas of the bay, however, the Lagrange excess flow is generally less than 1 cm and rather weak in moving pollutants, therefore also less effective in self-purification. Since there are constant changes in direction of the Lagrange drift, the discharge of pollutants must be carried out at the right time in order to avoid polluting neighboring areas.

On the basis of research into the current, excess current and spread of pollutants in the Bohai, Dou Zhenxing, Huang Kexin [7806 0344 6580] and others have established a Bohai water quality model. Using the model in a computation of COD places of concentration showed full uniformity with actual test results. The said model can be used for the projection and forecasting of soluble pollutants and for the evaluation of environmental impacts; it provides a scientific means of environmental planning and water quality control in the Bohai and provides a constant mathematical model for the pollution and water quality in the Bohai. According to calculations, the discharge of pollutants from rivers south and north of Tianjin, according to the COD method of computation, has to be less than 200 tons per day in the dry season and must not exceed 300 tons per day in the high water season.

Further tests, observations and computations were made by Ling Beibei [3249 0271 0271] (1980) regarding the laws governing the dispersal in small-scale water level turbulence. Wan Zhaozhong [5502 5128 1813] (1982) carried out an initial investigation of the dispersal and drift of petroleum in seawater. Jiang Tailliang [1203 1132 5328] (1983) conducted tests on the dispersal of pollutants in the ocean near Xiaogongdao close to Qingdao. Tang Yongluan [0781 3057 7019] (1980, 1982) also studied the drift and dispersal of pollutants in the sea outside the mouth of the Zhu Jiang.

According to a report by Zhou Jiayi [0719 1367 5030] (1980), in stations fairly remote from the sources of pollution outside of Jiaozhou Bay and along the shore and in the bay of the Huanghai, organic mercury compounds make up 11 to 17 percent of the total presence of mercury in the seawater, in fact most mercury existing in the form of organic compounds of mercury. Mercury that drifts out from the mouths of the rivers into the sea is primarily not in the form of methyl-mercury. He Yueqiang [0149 1878 1739] (1982) pointed out that mercury in sea floor sediment of the Guangdong coastal waters is derived not only from mainland pollution sources, but also entering the sea directly from rivers and from surface runoff because the sediment on the sea floor along the

coast is mainly carried into the sea by rainwater which erodes the coast. The mercury content on the sea floor is, therefore, not only related to the mercury content in the seawater, but also to the mercury content in the soil of the coastal land and in the sediment of the riverbeds.

The chromium in the waste water that is discharged into Jiaozhou Bay is of the sixth valence, but transformed by the organic matter and other reducing materials to the third valence, then adsorbed by particulate matter floating in the water and precipitated to the ocean floor. This is probably one system of mechanical self-purification as far as chromium is concerned. The sediment on the sea floor strongly adsorbs chromium in the third, but basically none of the sixth valence (Zhou Jiayi, 1980). The chromium in particle form in the surface water of the Bohai Bay is truly related to the content of organic material. It has been determined that with an increase of organic matter by 1 ppm of COD in the seawater, the chromium in particulate form will increase by 4.33 ppm (Huang Huarui, 1983). Zhang Sui [1728 4482] (1983) reported that the seawater near the coast of West Guangdong contains large quantities of inorganic cohesive particles of water and ferric oxide, water and aluminum oxide, manganese oxide and clay, and silicon dioxide, also large amounts of colloids of decayed plant matter and biomass debris. These items easily adsorb chromium of third valence, also serve as drift carriers for chromium of third valence. It has been determined that lead exists in Jiaozhou Bay waters mainly as compounds; these account for 50 percent of the soluble lead and 35 percent of all lead. Weakly bound lead accounts for 26 percent of all lead in the water, but there is a firm link with the COD in the water (Sun Bingyi [1327 4426 0001] (1980). Wang Zhengfang [3769 2973 2455] (1982) reported that the zinc found in the ocean off the mouth of the Chang Jiang is in free state, in the form of chelate rings of their elements or in particulate form; they account for the following proportions in the total zinc content of the seawater: 12.5 to 38 percent, 36.7 to 51.9 percent and 24.3 to 61.8 percent, respectively. The proportion of zinc in particulate form in the waters off the Chang Jiang mouth are 13 percent higher than in Jiaozhou Bay (Wang Shuchang [3769 1859 2490] (1980), possibly because of the larger amounts of organic matter and silt at the mouth of the Chang Jiang. The copper, chromium and mercury carried by the water from the mouth of the Chang Jiang, together with newly forming inorganic and organic colloids, will, on entering the sea with its greater salinity, wad together and precipitate to the ocean floor, thus purifying the water from harmful heavy metals (Wu Yudian [0702 3842 4551] (1982).

Liu Mingxing [0491 2494 2502] (1983) reported on the distribution of zinc, cadmium, lead and copper in the northwestern parts of the Bohai. Zheng Jianlu [6774 1696 4389] (1982), Wang Zhaoding [3769 5128 7844] (1982) and He Qingxi [0149 3237 3305] (1983) did some very thorough research into the solubility of such heavy metal pollutants as zinc, cadmium, lead and copper in the waters at the mouth of the Zhu Jiang and into the primary and secondary stages of chemical purification. Zheng Jianlu expressed the opinion that most of the heavy metal elements, on entering the waters at the mouth of the Zhu Jiang, undergo a change on contacts with rotting vegetation and other organic matter by exchanges and adsorption, they precipitate, condense, transform into a state of unstable organic matter (MI2) and also drift away. This is the primary stage of the purification process. As this unstable organic matter is



transported away from the river mouth, it continuously comes into contact with such colloids as inorganic silicates,  $\text{Fe}(\text{OH})_3$  and  $\text{Al}(\text{OH})_3$ , when exchanges and complexing takes place, forming stable compounds of inorganic colloids and complexes of adsorbed heavy metals, which finally end up in the ocean. This, then, is the secondary stage of the chemical purification process. The sea off the mouth of the Zhu Jiang has a very strong capacity for chemical self-purification as regards heavy metal pollutants. This may be one of the reasons why the region off the mouth of the river shows only very light pollution, although there is actually a certain measure of pollution at the mouth of the river. Apart from the question of heavy metals, the occurrence of uranium (Li Peiquan, 1981) and man-made nuclides (Xu Mingde, 1982) in seawater was also preliminarily investigated. As revealed in a determination of concentration of heavy metal in the sediment in parts of the Bohai and in distances from shore, the two factors are in a relation of a power function. After the heavy metals enter the ocean from the sources of pollution, their concentration in the 0 to 5 km range quickly declines, afterwards the decline is extremely slow, and the order of the decline is:  $\text{Hg} > \text{Cu} > \text{Cd} > \text{Zn} > \text{Pb}$ .

In the biological purification of the oceans, micro-organisms play an important role. Ding Meili [0002 5019 7787] (1979) was the first to investigate meticulously the types and the distribution of bacteria that break down petroleum in the surface water and in the sediment, and their effect on the oil pollution of the seawater. Later, under the sponsorship of the Environmental Protection Bureau of Tianjin Municipality, 13 entities, among them the Oceanographic Institute of the Chinese Academy of Sciences, also launched research into the environmental quality of the Bohai Bay and its capacity for self-purification (Zhang Jingyong [1728 2529 6978] 1980, Chen Haowen [7115 4110 2429] (1980), Wu Baoling [0702 1405] (1982). Bacteria that decompose petroleum are widespread in the waters and in the sediment of the Jiaozhou and Bohai bays, and their quantity is closely linked to the degree of oil pollution. It has been calculated that if the concentration of petroleum in natural seawater is 10 ppm the amount of petroleum decomposed in every liter of seawater by micro-organisms in 10 days is 0.5 mg. In addition, the first and third research institute of the State Oceanography Bureau also engaged in research into the bacteria that decompose petroleum in the waters of the Bohai and in Xiamen Harbor. Chromium is one of the main pollutants in Jiaozhou Bay. Chen Haowen (1981) reported on the chromium-resistant bacteria brought in by the tide and along the coast of Jiaozhou Bay. Shen Shize [3088 0013 3419] and Sun Guoyu [1327 0948 3768] (1983) carried out experiments in the purification of chromium-containing wastewater by means of micro-organisms.

In the last few years, Chinese workers in the science of marine environment also carried out many experiments to determine various pollutants contained in the biological system of the ocean and experiments on the absorption and concentration of various pollutants in marine biology. Using micronuclei of "zilu [4793 7216]" grass to monitor environmental pollution, they carried out experiments regarding the toxic effects of various kinds of pollutants on marine biology, to provide basic data that would help determine norms for discharge of waste material into the sea and to clarify comprehensively the biogeochemical processes that take place after the pollutants enter the sea. It is gratifying to note that this research is being pursued most thoroughly

and continuously. For instance, Wu Baoling and professor Lobel (1982) cooperated in determining the Zn, Cu and Fe content in *nephtys hombergi* at the mouth of the Tyne in England and probed into the relationship between the contents of these elements in the fauna and their weight and sex. Chen Xulong [7115 0650 7893] (1982) reported on the relationship between the forms of mercury contained in certain commercial types of fish in the Bohai and their edibility and age. Wu Baoling (1983) and others reported on the effect of cadmium and chromium on two colonies of *Capitella capitata* of the Polychaeta class of Annalides. The results of 96 and 1/2 hours of testing to determine the lethal concentrations were: the sensitivity to chromium of the Qingdao colony of *Capitella capitata* living in the western Pacific was about 27 times higher than that of the colony living on the eastern Pacific at Long Beach, California. However, the opposite was the case in connection with cadmium, in that the sensitivity of the Qingdao colony was somewhat deficient. These experiments reveal to us that there are geographical differences in the sensitivity of organisms toward pollutants, and that foreign data may only provide references, but that we must, therefore, rely on the results of our own scientific experiments when we draw up rules for the protection of the marine environment.

It is worthwhile to mention in particular the research into the effects on human health of pollutants in the Bohai and Huanghai, carried out jointly by the Public Health Research Institute of the Chinese Academy of Medicine and the epidemic prevention stations of Liaoning, Hebei, Tianjin, Shandong and Jiangsu. Over the last few years, they established 36 observation stations along the coast of the Bohai and the Huanghai and conducted hygienic investigations of almost 1.28 million fishermen and nearby peasants. Their investigations comprised the following: Hg, As, Cd and Pb in hair; the total Hg, As, Pb, Cd, Cr, DDT and BHC in human urine; DDT and BHC in human milk; DDT and BHC in human fat; total Hg, As, Pb, Cd, Cr, DDT, BHC and benzopyrene (a) in marine foodstuffs. The major results obtained in these investigations was: The hair of fishermen along the coast contained more Hg, As, Pb and Cd than that of peasants in the neighboring areas, most conspicuous being mercury content. The revised death rate from malignant tumors among the fishermen along the coast was 82.19 per 100,000, markedly higher than the rate of 65.41 per 100,000 among peasants, and also higher than the revised death rate from malignant tumors of 66.92 per 100,000 according to the general nationwide survey conducted from 1973 to 1977. The four types of cancer in fishermen, in order of frequency, are stomach cancer, liver cancer, cancer of the esophagus and lung cancer, which all showed higher revised death rates than in peasants. The years of rapid increase in the death rate from malignant tumors among fishermen were one age group (5 years) earlier than in peasants. According to the results of the investigation, it is generally believed that, apart from the need to give consideration to marine environmental factors in connection with the higher death rate from malignant tumors and the higher mercury content in hair among fishermen as compared to peasants, no marked difference has so far been discovered between other aspects of the health of fishermen as compared to the health of the peasants (Wang Zishi [3769 1311 4258] 1983 and Lin Hanzong [2651 3352 1350] 1982).

The study of evaluating the quality of China's marine environment, although started rather late, is now generally regarded as important owing to the needs

of the four modernizations, and much research work has been launched in this respect. In the last few years, apart from conducting research into the methods and steps for an evaluation of China's marine environment and of the environmental quality of certain areas of the sea (Liao Xiangui [1675 0341 6311] 1980; Zhong Bingnan, 1980; Wu Jun [0702 0193] 1981, 1982; Wu Yudian, Geng Weimin [5105 4850 3046] 1982; Liu Diansheng [0491 3013 3932] 1982; Gong Wei [1362 0251] 1983; and the Environmental Protection Institute of Jinzhou Municipality, 1982), advance assessments have been carried out, as prescribed by the state, regarding the impact that certain key construction projects might have on the coastal environment. Instances of such are the evaluation of the impact of the Qinshan nuclear power plant in Zhejiang on the waters at the mouth of the Qiantang Jiang, and impact of the expansion of coal shipment facilities at Qinhuangdao port.

The above-mentioned environmental research and evaluation carried out in the Bohai, the Bohai Bay, and the bays of Dalian, Jinzhou, Jiaozhou and at Beidaihe were favorably commented upon at the achievement assessment meetings called on several occasions by the State Oceanography Bureau and the environmental protection departments in the provinces and municipalities concerned. In 1981, the Ocean Environment Branch of the Chinese Society for Environmental Science also called a scientific conference at which more than 100 scholarly papers were presented. In recent years, concerned Chinese departments furthermore, dispatched many marine environment study groups to visit the United States, Japan and Great Britain for observation and scientific exchanges.

### 3. Drawing up the "Marine Environment Protection Law"

The formulation and enactment of China's "Marine Environment Protection Law" is a major achievement of the last few years of China's research in marine environmental science. The formulation and enactment of the said law fully manifests the great importance attached by the party and the state to the development of marine affairs and to the protection of the marine environment. The development of the oceans has become one of the major components of the new technological revolution. China has an ocean coastline of over 18,000 km, has vast territorial waters and ocean areas under its jurisdiction, and has abundant oceanic resources. For instance, the surface of China's coastal waters suitable for fishery exceeds the surface of currently available cultivable land by about 2.2 billion mu. The proven resources of oil and natural gas under China's coastal waters are extremely abundant. The development of the ocean and protection of the marine environment are affairs of strategic significance in China's economic construction. Investigations have revealed that the discharge of large quantities of harmful substances have had an impact on the waters at the mouths of rivers and on harbors and coastal waters. The effective protection of China's ocean environment requires, of course, a correct developmental policy and scientific and technological procedures. However, lack of a certain measure of strict management and control, particularly the lack of a sound legal system, will lead to unimaginable consequences. Foreign experiences also reveal that strengthening the legal system is a fundamental measure for the prevention and elimination of marine pollution (Li Zhengzong [2621 2973 1350] 1982; Zhu Xiaocheng [4376 2400 4453] 1982; RENMIN RIBAO commentator, 1982; Xu Qianfei



[6079 0467 7378] 1983; Li Ximing [2621 6932 6900] 1983). The formulation of the "Marine Environment Protection Law of the PRC," having had reference to the experiences of other countries, integrating the national conditions of China and based on 3 years of extensive research, was adopted at the 24th Session of the Standing Committee of the NPC on 23 August 1982, and has officially become effective on 1 March 1983 (see RENMIN RIBAO of 25 August 1982). It signifies that China's protection of the marine environment has now entered a new historical phase, where law is the yardstick, where control of the marine environment will be strengthened, harm and pollution of our oceans will be prevented, the ecological balance will be protected, the health of the population will be ensured and where great developments in our marine affairs are bound to ensue, to benefit the welfare of generations to come (commentator of the MARINE ENVIRONMENTAL SCIENCE, 1982).

Formulation and promulgation of the "Marine Environment Protection Law" is a major event in our work in the science of the marine environment. The legal formulation of the law condenses the intelligent and diligent work of China's workers in the field of environmental science and of jurisprudence. We must treasure this achievement, subject it to conscientious study, actively propagate it and firmly implement it. We must engage in even more penetrating scientific research to provide even better methods and data for the implementation of the "Marine Environment Protection Law," rendering it more effective and perfect in actual practice.

#### 4. Some Suggestions

(1) To study conscientiously and implement the spirit of the Second All-China Conference on the Protection of the Environment; to further raise awareness for the significance of environmental protection of our oceans and of the promotion of further marine developments; to make clear that in the new situation when China's marine affairs have become a key task, on account of the offshore oil explorations, determining the research tasks and points of emphasis in the science of marine environment realistically determines the long-term program of research in the science of marine environment.

(2) To attach importance and give support to research topics that are currently not at all taken up, or just in their initial stage, such as ecological monitoring, sea-atmosphere exchanges, capacity of the ocean environment, the ecological impact of pollution, selection of waste disposal areas in the oceans and nature preserves in parts of the ocean. Self-purification capability and environmental evaluation must be listed as key topics for continuous and thorough research.

(3) Because of its long coastlines and vast ocean areas, there are great differences between the different areas in their natural and social environments and in the conditions of industrial and agricultural production on their shores. It is, therefore, necessary to act under the guidance of the local environmental protection departments and base actions on actual research, when formulating detailed enforcement regulations to implement the "Marine Environment Protection Law" in each particular district.

(4) The death rate due to malignant tumors among fishermen in the coastal regions is markedly higher than the rate among peasants, and the reasons for this phenomenon have to this date not yet been clarified. It is suggested that the public health departments organize a work force to engage in a thorough research of this problem.

(5) To organize a work force for intensified research into methods and instruments for the monitoring of marine pollution. The force should concentrate its efforts on such aspects as speed, accuracy and automation in its work so as to raise the level of monitoring of the pollution of China's oceans.

9808

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## ENVIRONMENTAL QUALITY

### ENVIRONMENTAL MANAGEMENT BASED ON ACTUAL CONDITIONS IN CHINA

Beijing ZHONGGUO HUANJING KEXUE [ENVIRONMENTAL SCIENCES IN CHINA] in Chinese  
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[Article by Zhu Zhongjie [4281 6988 2638] (The Chinese Society of Environmental Sciences) and Qi Aiping [7871 1947 1627] (The National Bureau of Environmental Protection): "A Study of the Basic Thought of Environmental Management According to the Actual Situation of Our Country"]

[Text] Marxist philosophy considers the world a material unity which operates in time and space according to its own intrinsic laws, and people's correct understanding is the correct representation in the mind of the laws of objective reality. Therefore, to strengthen environmental management we must analyze the universal characteristics of the environmental problem, the characteristics of our country's environmental problem and of our economy and society, and their laws, and proceeding from actual conditions, study and find solutions to our country's environmental problems. This paper attempts to briefly explore the basic thought regarding environmental management in our country.

#### I. The Basic Characteristics of Our Country's Environmental Problem

In general, the environmental problem is complex and extensive. Furthermore, because of the differences in natural setting and the state of economic-social development, the environmental problem exhibits a marked regional nature. Once the environmental problem reaches a serious stage, it becomes difficult to solve in a short space of time, especially because the renewal of natural ecology and the transformation and purification of certain pollutants take a long time.

In addition to these universal characteristics, our country's environmental problem has the following basic characteristics:

1. Our country's level of economic development is rather low, but environmental pollution and destruction of the natural ecology are already quite serious. This is impairing the physical health of the people and the sound development of the social economy.
2. Our country's environmental problem is intertwined with the population problem; overpopulation results in very great pressure on the environment,

and makes the solution of the environmental problem even more difficult.

3. Our country has approximately 400,000 industrial enterprises, over 90 percent of which are small-scale enterprises. Their technical equipment is backward, material loss is extremely large, and pollution is serious and moreover difficult to bring under control.

## II. Basic Thought Regarding Our Country's Environmental Management

Our country is a developing socialist country with a planned commodity economy exercising a combination of planned regulation and market regulation. At present we are in the midst of carrying out the restructuring of the economic system and the policy of opening to the outside world. By the year 2000, our country's total industrial and agricultural output value should be four times what it was in 1980. In light of the above-mentioned characteristics of our country's society and the environmental problem, administrative departments charged with environmental protection should acquire the following points of basic ideology:

1. They should base themselves on promoting the sound development of the economy.

As developing the economy and protecting the environment are both conflicting and unified parts of a whole, their mutually promoting aspect should be brought into full play, while their mutually conflicting aspect should be held in check, so as to both protect the environment and promote economic development. Only in this way can our country's environmental protection work be smoothly carried out.

(1) Protecting the environment and making rational use of resources should be considered a basic starting point for environmental protection work. Centering on this basic starting point, a policy of comprehensive use should be worked out and earnestly applied, pollution should be prevented and controlled in tandem with technological transformation, environmental management should be strengthened in tandem with economic management, and natural resources should be exploited and utilized in a rational way to protect and improve the ecological environment.

(2) The economic results of environmental protection work should be improved. The main measures include: a. improving analysis of the cost-effectiveness of environmental protection; b. making full use of nature's self-purification and self-adjustment capabilities; c. carrying out a general policy of putting prevention first, combining prevention and control, combining management and control, and using administration to promote control; d. advocating starting with prevention and treatment at specific locations and moving toward prevention and treatment at the regional level, developing from individual treatment to comprehensive treatment; e. adhering to the general policy of overall planning and rational distribution, and solving the environmental problem in the process of economic development.

(3) The principle that whoever pollutes should be responsible for treatment should be adhered to, and a policy and system of fund-raising for environmental protection should be carried out which relies mainly on decentralized raising of funds by local government, departments, enterprise units, and public agencies, supplemented by centralized state investment.

2. They should view the situation as a whole, and tackle the problem of environmental pollution in a comprehensive way.

Environmental management should adhere to the principle of viewing the situation as a whole, considering the environmental problem an organic part of society as a whole as well as considering the environmental problem a unity of organic relationships, and should investigate its various intrinsic aspects and relationships, to correctly handle the relationship between the whole and the parts and the relationships among the parts, in order to obtain the greatest overall benefit. In this connection, the following work should be emphasized:

(1) Considering the maintenance of the balanced cycle of the ecological environment and control of environmental pollution as an organic part of the social system, and by means of bringing environmental protection into the plans for national economic-social development, harmonizing the relationship of other aspects of society to the environment, balancing the relationship between economic-social development and environmental protection, and thus doing a good job of environmental management throughout the course of social development.

(2) Strengthening environmental programs and planning, and making them truly play a role as the "overall design" for environmental management.

(3) Strengthening comprehensive regional prevention and treatment. Comprehensively studying the population, resources, economic structure, natural conditions, extent of environmental pollution and destruction, and other factors, rationally setting up production, construction, daily living, and other activities in the region, working out regional environmental programs, and solving the environmental problem with overall planning.

(4) Comprehensively utilizing the results of scientific investigation in many fields to understand and solve environmental problems, and using administrative, economic, technical, legal, and propaganda and educational means to manage the environment.

3. They should have foresight and a long-term perspective.

The hysteretic nature of environmental problems requires our environmental management to have foresight and a long-term perspective. To this end, the following kinds of work should be strengthened.

(1) Conscientiously studying the major policies of the party and the state, closely following trends of economic and social development and their possible

impact on environmental protection work, and promptly proposing environmental countermeasures for prevention.

(2) Attaching great importance to environmental evaluation and forecasting. Carrying out environmental impact evaluation work in economic development and construction, and systematizing and standardizing it.

4. They should adhere to the principle of combining prevention, management, and control.

The general policy of combining prevention and control, with prevention as the priority, includes the following requirements: (1) adhering to overall planning and rational distribution; (2) adhering to a system of environmental impact evaluation and the system of giving adequate consideration to waste treatment during the design, construction, and production phases of plants; (3) taking the steps of comprehensive regional control and control within the enterprise for existing environmental pollution and destruction; (4) actively popularizing low-discharge or discharge-free process technology; (5) suitably subsidizing areas where destruction of the natural ecology is serious, and bringing the situation under control by taking appropriate technical and engineering measures.

5. They should have an orientation towards thorough management.

The idea of environmental protection as a basic national policy must be carried through in every department throughout the country and in every field of work, and form an environmental management system comprising planning department, economic departments, and other related departments (in other words, an overall system of organization for environmental management). The role of environmental protection departments in this environmental management system would be to plan, coordinate, supervise, and guide.

6. They should rely on the masses, and have everyone set to work.

Strengthen environmental propaganda work to give the people of the whole nation a good ecological awareness and bring them to consider protecting the environment their moral obligation.

7. They should make regional management the main focus.

The regional nature of environmental problems determines that environmental management must be carried out under the unified leadership of the state, with priority given to the local level.

8. They should develop a close integration with scientific research.

Environmental management departments should establish close ties with environmental research departments. Scientific research should serve management. Environmental managers should be diligent in study and inquiry, and determined to explore.



9. Unified state planning management should be combined with decentralized supervisory management.

Environmental protection should be brought into the process of working out state planning, and environmental protection and economic-social development should be comprehensively balanced, so that environmental problems can be solved in the process of social development. Environmental protection should be brought into the orbit of control of unified state planning; that is, important targets of environmental protection planning and of economic-social development planning should be issued, put into effect, supervised, and checked up on in a unified way, so as to change environmental protection work from its present status of a task which is loosely-defined and monitored to one which is strictly-defined and monitored.

As for the problem of pollution from the multitude of rural small enterprises, individual enterprises, foreign capital enterprises, and others for which unified planning and management in environmental protection work is not appropriate, control should be exercised over them through economic and legal means of supervision.

10. A system of strict responsibility for environmental protection should be established on a national scale.

This responsibility system for environmental protection should incorporate at least the following three features: (1) for localities and departments, a system of environmental protection responsibility toward the state; (2) for grassroots production and construction units, a system of environmental protection responsibility toward the local government and toward their affiliated organizations; (3) for environmental protection departments at various levels of the state and locality, a system of environmental protection responsibility toward various levels of the national and local government.

The ten aspects above form an integrated whole of interconnections which come together in the basic process of environmental management. These ten basic concepts find their respective expression in the three environmental management functions of planning, organization, and control. The first four concepts are to be regarded chiefly as guiding principles for the process of strategic planning in environmental management; the fifth through the eighth as guiding principles for the process of organization in environmental management; and the ninth and tenth as guiding principles for the process of control in environmental management.

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ENVIRONMENTAL QUALITY

DEVELOPMENTS IN ENVIRONMENTAL SCIENCE AT CHINESE ACADEMY OF SCIENCES

Beijing ZHONGGUO HUANJING KEXUE [ENVIRONMENTAL SCIENCE IN CHINA] in Chinese No 2, 21 Apr 85 pp 49-53

[Article by Ma Shijun [7456 0013 7486], Environmental Science Committee, Chinese Academy of Sciences, and Yu Wentao [0151 2429 3447], Institute of Environmental Chemistry, Chinese Academy of Sciences: "Developments in Environmental Science Research at the Chinese Academy of Sciences"]

[Text] Environmental science is a new science of a comprehensive nature.

Environmental science studies the changes in the quality of the environment that occur in the course of modern (including contemporary) socioeconomic developments. It studies the origin, processes and consequences of the changes in environmental quality, and, furthermore, seeks ways and technological means to resolve environmental problems.

A decade or so ago, Premier Zhou Enlai repeatedly directed the Chinese Academy of Sciences (CAS) to engage in environmental protection work. In 1972, the CAS started research into the science and technology of the environment, geared to needs that arose from the tasks of the state, starting out from the prevailing conditions of environmental pollution and integrating its extensive with its intensive aspects. Investigation, research, analyses, evaluations and forecasts were directed, on the one hand, toward the extensive aspects of pollution, while engaging, on the other hand, also in a penetrating probe into a series of intensive mechanisms and biological impacts, seeking measures and ways to control and improve the environment.

We have by now advanced from the original study of control technologies concentrating on individual sources of industrial pollution to the study of comprehensive pollution prevention of entire regions. We have advanced from the study of environmental pollution caused by industrial pollution to a study of the destruction of the entire ecological environment by human activity and to a study of how to protect our natural resources. We have expanded the scope of our research from the fields of natural sciences, engineering and technology to comprise also the social sciences, so as to engage in an all-embracing study of China's environmental problems in their scientific-technological, as well as economic and social aspects. In the course of our actual endeavors to solve China's environmental problems, we have also

promoted the development of China's environmental science and technology and the study of such subdisciplines as environmental geography, environmental biology, environmental chemistry, environmental acoustics, environmental engineering, environmental medicine, as well as environmental management, economics and jurisprudence, all conserving unique Chinese characteristics, and all disciplines to mutually cooperate and interact in an extremely active scholarly spirit. During the last decade or so, environmental science and technology advanced very rapidly, and excellent achievements have been registered in all fields. They reflected, to a certain degree, the state and level of developments in environmental science in China and indicated that a field of environmental science with unique Chinese characteristics has indeed already emerged.

#### CAS Achievements in Environmental Science and Technology Research During the Past Decade

During the past decade or so, environmental science research at the CAS has rapidly developed from a state of nonexistence to its present state. Guided by an ideology of achieving comprehensive controls, and in cooperation with other entities concerned, over 500 research results have been achieved in environmental monitoring technology, environmental quality evaluation, techniques of environmental pollution prevention and in the study of environmental theories. These research results are of a certain practical significance, but also of a high academic level.

##### (1) Investigation and Monitoring of Environmental Pollution and Comprehensive Regional Environmental Research

Beginning in 1972, an investigation was launched into the state of environmental pollution of river systems, regions of the ocean and of cities. Research of river system pollution concentrated mainly on the protection of the water resources of the Guanting water system, the Baiyang marshes and the Jiyun He. Research of oceanic regions concentrated mainly on an investigation of the oil pollution in the Bohai and the northern regions of the Huanghai and on ways and means to prevent such pollution. Research on industrial and urban pollution concentrated mainly on the environmental evaluation of the western suburbs of Beijing. In addition, environmental investigations and monitoring was also carried out by means of chemical analyses, biological indices, telemetry and remote sensing. A number of specialized or commonly applicable instruments for analyses and monitoring were developed. China's first atmospheric pollution monitoring vehicle and the first water pollution monitoring ship were successfully developed in a joint large-scale cooperative effort to solve these key problems. Standard analytical methods and standard sampling methods were also developed. In the course of investigating the organic pollution in the waters of the Secondary Songhua Jiang, 394 organic pollutants were discovered in its water, and quantitative data in the thousands were obtained regarding 177 types of organisms and 10 chief indices (COD, BOD, pH, etc.). Research was, furthermore, instituted into the background value of elements in the soil and vegetation around certain Chinese cities, into the background value of trace elements and harmful substances in the natural water of water systems, oceanic regions and at the mouth of rivers. Research was also instituted into the content of trace elements in

the ice and snow, the rocks, soil and organisms in the remote regions of the Zhumulangma Peak. Some parts of the above-mentioned research were pioneering feats in the development of China's environmental science, by which basic materials and data on the state of pollution and on the quality of environmental controls in China were gathered.

When instituting regional environmental research, it is necessary to establish the environmental conditions and main environmental characteristics of the region in question, to search out the causes for its environmental pollution and for the destruction of its ecological balance and the laws governing such changes. It is necessary to gradually set up a research system that integrates the historical with the current conditions, the extensive with the intensive aspects, the static with the kinetic phenomena, the overall consideration of the entire ecological balance with economic considerations. It is necessary to make full use of the purification capacity of natural forces, to regulate the natural environment, to integrate economic benefits with ecological benefits and to have the ecosystem move in perfect cycles. For so broad a research field, it is necessary to have many disciplines and a great variety of forces cooperate in research work, also necessary to employ the methods of system analysis, to build models of many parameters and for many purposes, and to gain a clearer and more accurate scientific evaluation of the environment.

In the last few years, the CAS, in cooperation with other entities concerned, completed such key research topics of the state as the "Environmental Study of the Beijing-Tianjin-Bohai Region," "Study of Comprehensive Pollution Prevention of the Xiang Jiang Water Resources," "Study of Pollution of the Secondary Songhua Jiang and Protection of Its Water Resources," and "Comprehensive Control of the Waters of the Jiyun He System." In the course of comprehensive research into regional environments, certain procedures and methods for regional environmental research work were evolved, accumulating a large volume of materials and experiences and discovering certain laws and means for the comprehensive control of regional environmental problems in China.

## (2) Control of Sources and Comprehensive Prevention of Pollution

The relevant institutes of the CAS observed the following two principles in their work of controlling the sources of pollution: One, organization of a work force and launching research as and when the state or production departments demand such work or assign such tasks. Two, avoiding duplications by mainly giving priority to research concerned with new methods, new materials, new technologies and new techniques.

In the early years of the 1970's, the Environmental Protection Office of the State Council, considering the prevailing conditions of industrial pollution in China, designated phenol, cyanogen, mercury, chromium and arsenic as the major pollutants to be controlled and regulated, because they occur in large quantities and over wide areas. The CAS, in combination with its various tasks, established certain measures for the control of phenol, cyanogen, mercury, chromium and arsenic. On an inspection tour of the Beijing Dongfanghong Oil Refinery, Premier Zhou Enlai left instructions to get rid of



the yellow smoke, whereupon the CAS immediately launched a study into the elimination of the nitrogen oxide pollutant by means of catalytic reduction. Aiming at the control of pollutants that occur in large quantities and that are widespread, the F-53 chrome fog inhibitor, chromium-plating techniques without emission of pollutants and multilayer fluidization techniques were evolved as measures showing greatest economic and environmental benefits. In compliance with demands and tasks put forward by production departments, control measures were instituted in connection with the production of phosphate for agricultural use, fur and hide dyestuffs, waste water from printing and dyeing, from acrylonitrile production, low concentrations of sulfur dioxide, cinematographic film production and waste water from TNT production.

Based on fundamental chemical and biological theories and techniques, new techniques, new technologies, new materials and new methods of universal significance were explored for the prevention of pollution, while research was at the same time instituted into preventive technologies employing a combination of various means, for instance, using thermometal in the catalytic oxydization method for treating DDT waste water, physical and chemical methods in the thorough purification of waste water from printing and dyeing, reverse permeable membranes--the preparation of sulfonated polysulfone, the study and use of polysulfonated ultrafiltration membranes, use of humic acid resin in the purification of heavy metal-containing waste water, solvent extraction methods in the treatment of fenitrophion-containing phenol waste water, highly effective phenol recovery by phenol extraction agent N-503, etc. As to the rational use of nonharmful energy and other resources, research was instituted into the use of a methanol-gasoline mixture as fuel in gasoline engines, into raising the combustion efficiency of open stoves with a reduction of indoor pollution and into raising the combustion efficiency of honeycomb stoves with a reduction of pollutants.

Research into the formation and control of deserts and the prevention of desertification is of actual significance for the development of China's Great Northwest. Applied fundamental research was in this connection directed toward the problem of damage from trichlorometaldehyde in wheat fields at Tianjin and other places, and a thorough research was started into the transformational laws of trichlorometaldehyde in the soil. It was discovered that it was turned into the more harmful trichloroacetic acid by microorganisms in the soil, and it was not breaking down, as generally intimated in chemical literature, into such simple chemical compounds as carbon dioxide and water, thus not undergoing an induced reaction. The control measures suggested were, therefore, leaching or loosening the soil and the preservation of humidity in the soil. These lines of research are also of a certain scholarly significance.

In consideration of the principles of ecology as well as economics, the solution to problems of environmental protection must not merely be sought by paying attention to the control of individual cases, but must also pay attention to comprehensive control and the overall apportionment of gain and loss, seeking ways that provide solutions for the common problems of larger regions. As to comprehensive preventive measures, the CAS, with the cooperation of local entities, has been successful in certain items of

scientific research, as, for instance, in the control of pollution in the Yaer Hu, in research into the purification mechanism of agricultural chemicals in oxidation ponds, in the comprehensive analysis of conservation measures for the water system of the Jiyun He, and in its research into the control of waterway pollution. In achieving these research results, full use was made of the capacity of natural forces to purify pollutants, and according to the principle of comprehensive control, primary consideration was always given to the use and strengthening of this purification capacity of the environment itself. Substances which the environment cannot purify, especially heavy metals and organic matters that will not easily break down, must be treated at the source of the pollution. There must be an integration of natural purification with industrial treatment, in order to achieve the largest possible reduction of pollution and at the same time lighten the burden of control obligations now resting on factories. It is, therefore, very evident that comprehensive control is the major method to resolve and prevent industrial pollution.

As to research into the causes and the control of noise, the CAS first investigated the traffic noise in Beijing in 1973. In 1976, a widespread investigation of traffic noise was carried out, with the cooperation of the cities of Beijing, Tianjin, Guangzhou, Nanjing, Hangzhou, Wuhan, Chongqing and Harbin. The city noise in each place was studied, and certain important rules governing the distribution of urban noise in China were derived from these studies, which resulted in two proposals as to methods of measuring noise in Chinese cities and as to setting up relevant environmental standards. These were later adopted by the State Standards Bureau and the Ministry of Urban and Rural Construction and Environmental Protection, to be applied as valid standards throughout the country. In addition, good progress was also made in the study of airflow noise, the effects of noise, noise absorption and insulation against noise, evolving theories on the production and regulation of jet noise and successfully developing micropole diffusers and microperforated ceramic sound absorbers, also gaining certain successes in the control of industrial noises.

### (3) Study of Ecological Pollution and Environmental Toxicity

When starting research on the impact of pollution on the ecosystems of life in water and on land and of farmland, on the toxicity of the environment and environmental influences on human health, the CAS came to recognize the impact of pollutants on the structure and functions of the ecosystem, and clarified its functional mechanism, probed into ways of regulating and controlling these influences and provided scientific data for the prevention of damage and destruction by pollutants of the productive capacities of the ecosystem.

As regards the impact of pollution on the aquatic ecosystem, investigations were instituted, in cooperation with other entities concerned into the waters of the Guanting Reservoir, the Baiyang marshes, the Jiyun He, the Xiang Jiang, the Tumen Jiang, the Secondary Songhua Jiang and the Huanghai and Bohai. The large quantity of materials from these investigations indicate that pollution has indeed an impact on the structure and functions of the aquatic ecosystem. Conversely, the changes in the aquatic ecosystem make it possible to evaluate the degree of pollution in a body of water and provide data for pollution



control. For instance, in connection with the work of protecting the water resources of the Guanting Reservoir, studies were made on the relationship of pollution to the growth and reproduction characteristics of carp in the reservoir, and information was gathered on arsenic and chromium in the flesh and internal organs of five types of commercial fish--carp, crucian carp, bream, catfish and bighead--and on the distribution of such pollutants in their systems. The research clearly demonstrated that the aquatic ecosystem has a certain capacity for self-purification, that it is even possible to utilize waste water in a variety of ways, turning waste into valuable substances, and successful experiences have been gathered in this respect at the sewage reservoirs at the Yaer Hu and at Hangu in Hubei Province. The research has, furthermore, shown that certain high-grade aquatic plants--water hyacinth, bulrush, reed mace, reeds and pondweed--have the capacity to absorb, accumulate and purify heavy metals in waste water.

As to the impact of pollutants on plant or animal life, research has been carried out into the effects of phenol, cyanogen, mercury, arsenic, cadmium, lead and zinc on crops. The degree of impact is not only determined by the quantity of pollutant extant, but also by the physical and chemical character of the soil, the degree of acidity and alkalinity, the quantity of humic matter, the conditions of oxidoreduction in the soil, etc. The research also clarified that pollutants had different effects on different crops, and demonstrated certain laws governing the absorption in the different parts of the crop (roots, stalks, leaves, seeds) during different stages of growth. This provided us with scientific data for a better understanding of the self-purification capacity, for the use of waste water in the irrigation of farmland and for ways of preventing pollution. The effect of irrigation by waste water on the ecosystem of farmland is a very complex problem. We are opposed to the blind use of waste water for irrigation of farmland, unless it has been subjected to a thorough study and treatment; what we advocate is a scientific treatment of waste water for irrigation.

The study of the impact of atmospheric pollution on plants and social functions, these complex functional processes again are subject to the regional influences of the natural ecological-geographical environment. To gain knowledge of the harmful mechanism of pollutants and their movements, it is necessary to start out from a consideration of the region as a whole and institute research in an integration of microscopic analyses and magnoscopic inclusiveness, only then will it be possible to arrive at effective preventive measures. Accordingly, in the early years of the 1970's, the CAS integrated its tasks connected with the Guanting Reservoir, and carried out research on the relationship between the self-purification capacity and the surrounding natural ecological environment, coming up with a comprehensive control policy that integrates technological treatment and environmental self-purification.

The reason why environmental problems are currently coming more and more into the limelight is that during the period of rapid technical and economic development, the regulatory functions of the ecosystem had been neglected in a mad rush for immediate profits. To guard against this erroneous tendency it is necessary to adopt the principles of ecology and economics in the further construction of industry and agriculture, so that both sets of norms, those of economic benefits and those of ecological benefits, will be implemented when

determining future economic construction plans. Only in this way will it be possible to prevent the environment from deteriorating further in the course of our on-going economic development.

The rational exploitation and use of our natural resources relates not only to the supply of industrial raw materials, but also touches on the handling of waste matter. We, therefore, have applied the principle of multi-level, multi-graded use of materials and energy of the ecological system, combined with a summing up of our Sangji fish pond experiences, in presenting plans for ecological engineering in order to point out the direction of an industrial development without pollution and without waste matter.

Since the last years of the 1970's, there has been a rapid socioeconomic development, demanding prompt improvements in the people's material and spiritual livelihood. We are, therefore, faced with the complex problem of a rational development, utilization and mutual interaction of socioeconomics, contemporary science and technology and the natural resources. This problem is particularly crucial in the cities (including their suburbs) and in industrial and mining areas. The current environmental problems have been produced precisely by an imbalance between the three systems mentioned. We can foresee that as the contradictions between the three systems worsen, the environmental problems will intensify. It is for this reason that we set forth our idea of a "composite ecosystem comprising societal, economic and natural factors," and to handle the three categories of different systems as one composite system, that we have analyzed the ecological characteristics of this composite system and that we put forward three principles to appraise this composite system: (1) the rationality of the natural system; (2) the profits of the economic system; (3) the benefits of the social system. We are pointing out that the research into this composite ecological system is a process of making policy decisions regarding many objectives. Guided by the principles of economics and ecology, we must determine the specific social objectives, economic objectives and ecological objectives and achieve a system with a maximum of comprehensive benefits, with a minimum of risks and with the greatest chances for our survival.

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9808

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11 July 1985

## Acoustics

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TITLE: "Acoustical Remote Sensing and Acoustical Method of Classification of Marine Sediments"

SOURCE: Beijing YINGYONG SHENGXUE [APPLIED ACOUSTICS] in Chinese Vol 4, No 1, Jan 85 pp 2-4

ABSTRACT: Oceanographic study and marine exploration are important in the new revolution of technology. In exploration, there is a need to understand seabed sediments and strata; in the past, expensive drilling and sampling was carried out. Therefore, it is necessary to apply the acoustical method to explore seabed sediments and ore resources. Remote sensing of seabed acoustical parameters can be divided into remote sensing of sound attenuation in seabed sediments, measurement of the speed of sound of the seabed, and measurement of the seabed sound reflection coefficient or reflection losses. The sound reflection technique is most widely applied in marine exploration of petroleum; thousands of tow cables are used with the explosion of charges. The isopleth-points method is used and the data obtained are processed on a computer. Thus, relatively fine structure in seabed strata can be visualized. The developing three-dimensional seismic method and lithofacies method can envision even finer structures. By adopting the acoustical classification method of marine sediments, the author and his colleagues used a shallow strata profile instrument to measure the correlation coefficient between echoes, thus deriving a relationship between the correlation coefficient and sediment porosity. It was discovered that the correlation coefficient rapidly decreases at the trailing edges of echoes for sediments with higher porosities. When echo waveforms with high-frequency narrow-beam incident vertically into the seabed are analyzed, the attenuation rate at the trailing edges of echo waveforms is related to sediment characteristics, thus determining the sediment classification.

10424

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TITLE: "5-250 MHz Ultrasonic Attenuation and Velocity Measuring Instrument"

SOURCE: Beijing YINGYONG SHENGXUE [APPLIED ACOUSTICS] in Chinese Vol 4, No 1, Jan 85 pp 22-25

ABSTRACT: The paper reports the development of a 5-250 MHz ultrasonic attenuation sound velocity instrument; it uses the measurement method of comparing the reflected pulse echo array and the index attenuation waveform to obtain the attenuation coefficient dB/ $\mu$ s or dB/cm. By taking readings on calibrated disk of a potentiometer and referring to the marking curve of the attenuation coefficient, its value can be obtained. Or else two pulses can be randomly selected with a gate circuit from an echo array of reflected pulses. Then the pulses are amplified from a video frequency pulse logarithmic differential amplifier; the selected pulses are displayed on an oscillograph or automatically recorded on a X-Y function recorder. Another paper will present the experiments of ultrasonic attenuation and measurement of sound velocity by using the instrument, under discussion, whose block diagram is shown in one of the six figures. The five other figures show the pulse duration of the modulating pulse waveform, the waveform of transmission pulse, the reflected echo arrays in molten quartz and  $\text{LiNbO}_3$ , and two gate echo pulses transmitted to the logarithmic differential amplifier. Two tables show the operating frequencies, waveband and the corresponding frequency range on a 5-250 MHz transmitting frequency pulse generator, and local-oscillation frequencies corresponding to six wavebands.

The authors thank Lin Qingsbo [2651 3237 3134] of Acoustics Institute of Nanjing University for counsels on study of the instrument. The paper was received for publication on 5 May 1983.

10424

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Acoustics

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TITLE: "An Electric Spark Type Impulsive Sound Source for Acoustic Measurement and Its Acoustic Characteristics"

SOURCE: Beijing YINGYONG SHENGXUE [APPLIED ACOUSTICS] in Chinese Vol 4, No 1, Jan 85 pp 32-35, 8

ABSTRACT: Sound pulses emitted by electric sparks have small duration, high sound level and nondirectional characteristics; therefore, these pulses are an ideal sound source for studying tone quality, pulse response, harmonic time and model experiments of a music hall. When the sound level is sufficiently high and stable, the sound source can be used for soundproofing measurements and near-field calibration of a shock wave transducer with high (sound) intensity. The authors adopted the approach of high-voltage, low-capacitance discharge. There are automatic, manual and remote control installations in the control circuit. The pulse acoustic generator uses a simple circuit with steady performance, compact assembly and convenient operation. The paper presents the principle of spark acoustic generator, characteristics of circuit design, acoustic characteristics of the sound source, and applications. One table lists peak values of sound pressure level one meter from the sound source. Five figures show three electrodes producing electric sparks, the electrical principle of spark pulse acoustic generator, its frequency response characteristics, response of pulses with and without wave filtering, and pulse responses in the area of audience seats in a music hall.

The authors thank associate professor Wang Jiqing [3769 1323 0615] and engineer Zhou Zhixiao [0719 1807 1321] for supporting the study, and colleague Fang Qiwen [3455 0796 2429] for assisting in the measurement of acoustical characteristics. The paper was received for publication on 8 February 1983.

10424  
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## Acoustics

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TITLE: "Radiation Pattern of Circular Transducer for Doppler Navigation"

SOURCE: Beijing YINGYONG SHENGXUE [APPLIED ACOUSTICS] in Chinese Vol 4, No 1, Jan 85 pp 36-40, 44

ABSTRACT: Traditionally when designing (directional characteristics of) a circular transducer with certain thickness, the one-dimensional plunger, uniform oscillation type is always adopted; however, actually this is a two-dimensional nonuniform oscillation type. When the author and his colleagues developed the SJH-100 model Doppler navigation velocity-measuring sonar transducer, they adopted a two-dimensional thickness-direction displacement superimposition model, and derived formulas for relatively accurate calculation of directional characteristics. The formulas were proved to be practical after measurements and computer calculations. This method may serve designers of sonar as well as ultrasonic and electroacoustic circular-disk thickness oscillation transducers. The paper discusses the effects on directional characteristics of transducer caused by copper shell, sound load and other acoustical configurations, thus providing a basis for revising certain parameters. Six figures show transducer layout, coordinate sketch diagram, characteristic values by using the thickness method, theoretical and measured directional characteristic curves of the transducer at E-E and B-B cross sections, and cross-section sketch diagram. Four tables list results (from tabulation and calculation) of various characteristic values, two types of oscillation amplitude distribution values with thickness-direction displacement, influence of some parameters when deriving directional characteristics, and measured data of directional characteristics of the SJH-100 model navigation sonar No 2 transducer.

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TITLE: "Recording of Three Dimensional Spectrum of Pulsed Ultrasonic Doppler  
Hemodynamics With Microcomputer"

SOURCE: Beijing YINGYONG SHENGXUE [APPLIED ACOUSTICS] in Chinese Vol 4, No 2,  
Apr 85 pp 13-17

ABSTRACT: The pulsed ultrasonic Doppler technique is an effective approach for diagnosing cardiovascular disease by nonintrusive scanning of the patient. However, the function is limited on the real-time frequency spectrum display since it cannot be used for the dynamic quantitative analysis of the frequency shift spectrum. This paper presents the operating principle and configuration of a hemodynamic frequency spectrum tracing system using the pulsed ultrasonic Doppler technique with a Z80 single-board microcomputer and a Japanese-made SR-6602 automatic plotter. Also presented are the interface diagram with a MK 500 hemodynamic analysis instrument, and the preliminary clinical results. The microcomputer device can accurately collect 1.2 seconds of data on the pulsed ultrasonic Doppler hemodynamics; the data can be recorded on magnetic tape storage or traced with three-dimensional frequency spectral diagrams. As shown in clinical use, this technique can provide abundant data on hemodynamics; this is an effective way of quantitatively analyzing cardiovascular diseases. The instrument is steady in performance and is convenient to operate. Six figures show the transmission time sequence of hemodynamic frequency spectrum data, system flow diagram of three-dimensional tracing instrument, block diagram of a system monitoring program, three-dimensional display of the pulsed ultrasonic Doppler flow frequency spectrum, flow frequency spectrum of normal mitral-valve condition, and flow frequency spectrum of patients with mitral stenosis with complication of mitral insufficiency. The authors thank Doctor Qin Bingqi [4440 3521 0796] of General Hospital of the Chinese People's Liberation Army for his assistance. The paper was received for publication on 17 July 1984.

10424  
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TITLE: "Formulas for Calculating the Output Phase and Its Divergence for a Wide-band Hydrophone"

SOURCE: Beijing YINGYONG SHENGXUE [APPLIED ACOUSTICS] in Chinese Vol 4, No 2, Apr 85 pp 25-27

ABSTRACT: Beginning from a mechanical-electrical equivalent circuit, the authors observed the effect of the sound terminal load and electrical terminal interface to derive the relations for the hydrophone phase using the characteristic parameters (of piezoelectric type hydrophones), such as resonance frequency, dielectric loss, and low-frequency capacitance. By using those equations, a range of electroacoustic parameters can be selected as a basis in designing a piezoelectric hydrophone with the requirement of phase consistency. A quantitative estimate can be made on phase and divergence (here direct measurement is not feasible) of a hydrophone array from these equations, so they are practical in engineering design. Four figures show an equivalent circuit of the hydrophone, a simplified circuit, as well as curves of phase and operating frequency in one figure, and curves of phase divergency and operating frequency in the other figure. The paper was received for publication on 17 January 1983.

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TITLE: "KCF-A Ultrasonic Generator and Its Application in Synthesis of New Copolymers"

SOURCE: Beijing YINGYONG SHENGXUE [APPLIED ACOUSTICS] in Chinese Vol4, No 2, Apr 85 pp 18-20, 48

ABSTRACT: By the application of mechanical force, large molecules (ionized radicals) produced when high polymer chains are broken can be used to prepare inserted segment or grafted copolymers; this is an important subfield in high polymer chemistry. The paper describes a KCF-A model controllable silicon ultrasonic generator and magnetostrictive oscillation system for studying the degradation and copolymerization of polymers. Several types of inserted segments or grafted copolymers with new characteristics have been successfully synthesized, including nPAM-AN, PAM-PEO, PVAc-PEO, HPAM-PVAc, and HEC-PEO. The reaction time is short, generally several to tens of minutes long. This ultrasonic application is suitable to occasions when direct use is made of isolated polymers of low purity, such as high polymer materials used in exploring for oil and gas fields, lubricants in metal coldworking, and oil-base paint coatings, among other areas. Some copolymers obtained by this approach are difficult to be directly synthesized with the conventional chemical method owing to entirely different polymerization regimes. Six figures show the simplified main circuitry for the reversible reaction devices, current waveforms of the above-mentioned devices, a device for ultrasonic radiation reaction, phase difference microscopic photographs of PVAc and HPAM mixtures and copolymers, turbidity titration curves, and HEC-PEO cracking mass spectrum. The authors express their gratitude to Professor Xu Xi [1776 0296] for his guidance and revising the paper. The paper was received for publication on 18 August 1983.

10424  
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Aeronautics

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TITLE: "Principle of Plane-steady Nonviscous Flow and Minimum Entropy Production--Determination of the Simplest Physical Solution for the Problem of Multiple Solutions"

SOURCE: Beijing ZHONGGUO KEXUE--A J1 [SCIENTIA SINICA, Series A] in Chinese No 3, Mar 85 pp 243-251

ABSTRACT: This paper deals with a problem of plane-steady nonviscous flow. Beginning with the irreversible process and according to the principle of minimum entropy production, a determination inequality (for a feasible solution in physics) is derived. Explained by means of several simple examples with a vertically directed shock wave, the determination method of the minimum entropy production can distinguish between the practically infeasible physical solutions and multiple solutions that satisfy the conventional entropy conditions. This proves the instability of the state of the more intensive shock wave when an uniform supersonic flow moves along a wall with a corner. Through the discussion in the paper, it appears rational to apply the minimum entropy production principle related to the nonequilibrium steady state (in the problem of plane-steady nonviscous flow) as the supplementary condition in selecting the physical solution. From examples in the paper, this supplementary condition can serve in determining with just the entropy increment condition. In part II of the paper (to be published in this journal), the authors will further discuss the general problems of plane-steady nonviscous flow for the conditions of process irreversibility, which can be shown to replace the entropy conditions. Six figures show the turning angle  $\theta$  (of the wall) and the angle of inclination  $\beta$  of the shock wave, determination function, determination curve, polar line, Mach reflection of plane inclined shock wave reflected from a solid wall, and polar line of the shock wave. The paper was received for publication on 25 July 1984.

10424  
CSO: 4009/248

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TITLE: "A New Cubic Equation of State"

SOURCE: Beijing HUAGONG XUEBAO [JOURNAL OF CHEMICAL INDUSTRY AND ENGINEERING (CHINA)] in Chinese No 2, Jun 84 pp 149-156

TEXT OF ENGLISH ABSTRACT: On the basis of the Soave and Martin-Hou equations, a new cubic equation of state is suggested. Expressions for calculating its constants and the corresponding formulas for its thermodynamic functions were derived. Good agreement was obtained between literature values and results calculated from phase equilibrium constants and dew points for binary pairs.

7755

CSO: 4009/164

Chemical Industry

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TITLE: "Simplified Model for Size-Dependent Growth Rate of Crystals"

SOURCE: Beijing HUAGONG XUEBAO [JOURNAL OF CHEMICAL INDUSTRY AND ENGINEERING (CHINA)] in Chinese No 2, Jun 84 pp 164-170

TEXT OF ENGLISH ABSTRACT: For size dependent growth rate of crystals, a simplified model:

$$G = \frac{G_{\infty} L}{L + \beta}, \quad L > L_0 > 0$$

is derived, where  $G$  is the linear growth rate of crystals,  $L$  and  $L_0$  are characteristic lengths of crystals and nuclei, respectively,  $G_{\infty}$  and  $\beta$  are mod. parameters,  $G_{\infty}$  being the linear growth rate of extremely large crystals, and  $\beta$  characteristic length of crystals for which linear growth rate equals  $G_{\infty}/2$ .

Equations for crystal size distribution (CSD), suspension density  $M_T$  and dominant crystal size  $L_D$  are given.

Compared with previous models, most of which are empirical, this model shows a comparable or better fit to the published CDS data for ammonium alum and potash alum. The calculated values of  $M_T$  agree well with experimental results.

7755

CSO: 4009/164



# Chemical Industry

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TITLE: "Mathematical Model for the Production of Butanol From Low-Pressure Hydroformylation of Propene by a Complex Co-P Catalyst"

SOURCE: Beijing HUACONG XUEBAO [JOURNAL OF CHEMICAL INDUSTRY AND ENGINEERING (CHINA)] in Chinese No 2, Jun 84 pp 171-181

TEXT OF ENGLISH ABSTRACT: The mechanism and kinetics of hydroformylation of propene under low pressure were studied, pseudo-first-order equations were derived, and rate constants, activation energy and optimum contact time for producing butyl aldehyde were calculated.

Next, the influence of reactor diameter on absorption efficiency, mass transfer coefficient, axial mixing of liquid and average bubble diameter were examined. The result shows an obvious effect of bubble diameter on propene conversion. Hence, bubble diameter should be used as a significant factor for reactor scale-up.

A mathematical model based on experiments of hydroformylation of propene in a packed bubble reactor is as follows:

$$A/A_0 = e^{-\frac{t}{M} (k_1 + k_2 + k_3)}$$

where the coefficient of contact efficiency M can be obtained from a three-region model.

7755

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TITLE: "New Microscopic Method for Studying Phase Morphology of Thick Samples of Rubber Blends"

SOURCE: Beijing HUAGONG XUEBAO [JOURNAL OF CHEMICAL INDUSTRY AND ENGINEERING (CHINA)] in Chinese No 3, Sep 84 pp 278-282

TEXT OF ENGLISH ABSTRACT: A method was devised in which a single surface of a thick sample of unsaturated hydrocarbon rubber blends is stained by a  $\text{KMnO}_4$  aqueous solution for effective visualization of the sample's morphology under a microscope. Experience showed that the method is sensitive for incompatible blends such as NBR with EPDM, BR with LDPE or EVA/SBR/PE, and is applicable to compatible blends when mutual blending is not yet completed or dispersion is not satisfactory.

The advantage of this method lies in its simple preparation, ease of operation, low cost and freedom from morphological distortion. The strongly contrasting pictures resulting from this method can be used for examining thick samples without the use of the phase-contrast microscope or microtome. This method is thus expected to provide an effective means of quality control for mixing operations and of rapid measurement of homogeneity of dispersion.

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CSO: 4009/165

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TITLE: "Thermodynamic Analysis of Ammonia Synthesis Reactors"

SOURCE: Beijing HUAGONG XUEBAO [JOURNAL OF CHEMICAL INDUSTRY AND ENGINEERING (CHINA)] in Chinese No 3, Sep 84 pp 214-224

TEXT OF ENGLISH ABSTRACT: Based on the concepts of irreversible thermodynamics, a model for thermodynamic analysis of ammonia synthesis reactors is proposed. This model was checked by availability analysis of classical thermodynamics and calculation showed that the model gave good accuracy. The method is characterized by its ability to classify various kinds of energy losses and to correlate these losses to effects of kinetic factors. Various types of ammonia synthesis reactors were evaluated by means of the proposed model.

7755

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TITLE: "The Synthesis and Crystal Structure of  $\text{WCu}_4\text{S}_4\text{Cl}_2(\text{NC}_5\text{H}_5)_6$ "

SOURCE: Shanghai HUAXUE XUEBAO [ACTA CHIMICA SINICA] in Chinese Vol 43, No 2, Feb 85 pp 107-112

TEXT OF ENGLISH ABSTRACT: Reaction of  $(\text{NH}_4)_2\text{WS}_4$  with  $\text{CuCl}$  in pyridine in the presence of  $\text{NH}_2\text{OH}\cdot\text{HCl}$  and  $\text{PPh}_3$  leads to the formation of a red crystal  $\text{WCu}_4\text{S}_4\text{Cl}_2(\text{NC}_5\text{H}_5)_6$ . Its density is  $1.974 \text{ g/cm}^3$ . The crystal belongs to the monoclinic system, space group  $\text{C}_{2h}^6\text{-C2/c}$ , with  $a = 14.883(9)\text{\AA}$ ,  $b = 12.580(6)\text{\AA}$ ,  $c = 20.318(9)\text{\AA}$ ;  $\beta = 100.50(4)^\circ$ ;  $V = 3740(3)\text{\AA}^3$  and  $Z = 4$ . The intensity data were collected by SYNTEX-R3 four-circle diffractometer. The structure was solved by Patterson method and Fourier method and refined by least-squares with anisotropic thermal parameters. The value of  $R$  is 0.069. The molecule has  $\text{C}_2$  point group symmetry, with the following average principle dimensions:  $\text{W-C} = 2.673\text{\AA}$ ,  $\text{W-S} = 2.225\text{\AA}$ ,  $\angle\text{Cu-W-Cu} = 90.0^\circ$ . In the molecule, the central W atom was linked with four Cu atoms and four S atoms in the form of square and tetrahedron respectively. Each Cu atom was linked to the central W atom by double sulfur bridge and each Cu atom linked with another Cu atom by single sulfur bridge. The molecule contains a pyridine which locates disorderly. The compound belongs to tungsten-copper mixed metal cluster compound.

CSO: 4009/1039

AUTHOR: ZHENG Zhuxi [6774 2612 2737]  
WANG Zunben [3769 1415 2609]

ORG: Chemical Department of Xiamen University

TITLE: "Chemiluminescence in Environmental Analysis I., Determination of Chromium (III) in Natural and Polluted Waters"

SOURCE: Changchun FENXI HUAXUE [ANALYTICAL CHEMISTRY] in Chinese No 1, 20 Jan 84 pp 10-13

TEXT OF ENGLISH ABSTRACT: Based on the catalytic action of trace chromium (III) on the oxidation of luminol in an alkaline medium, a chemiluminous method for the determination of chromium (III) has been developed. During the reaction in progress, light of definite wavelength would emit, and its intensity is in proportion to the content of the chromium (III), while chromium (VI) has no chemiluminous effect. A luminous analyzer designed by the author and a continuous flow system for sample entering have been used. This method is simple and quick. Its sensitivity is high and the detection limit  $\leq 0.1$  ppb. The linear range is from  $10^{-9}M$  and  $10^{-6}M$  and the reproducibility is good. The analytical results are satisfactory.

12949

CSO: 4009/245



AUTHOR: ZHANG Rui [1728 4213]  
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ORG: Lanzhou Institute of Chemical Physics, Chinese Academy of Sciences

TITLE: "Application of Extended Kinetic Isotope Method--Comparison of Kinetic Behavior of Bi-Mo and Ferrite Catalysts Toward Butene Oxidative Dehydrogenation and Isomerization"

SOURCE: Beijing CUIHUA XUEBAO [JOURNAL OF CATALYSIS] in Chinese Vol 6 No 1, Mar 85 pp 1-7

TEXT OF ENGLISH ABSTRACT: The kinetics and mechanism of butene oxidative dehydrogenation and isomerization over Bi-Mo and ferrite catalysts have been analyzed by the extended kinetic isotope method (EKIM) with  $^{14}\text{C}$ -labeled butene as the tracer. The reaction was carried out in a micro-integral reactor, with a reaction temperature of  $485^\circ\text{C}$  for the Bi-Mo catalyst and  $330^\circ\text{C}$  for the ferrite catalyst.

Over the Bi-Mo catalyst, the selective oxidation was ascribed as first order in butene and zero order in oxygen. The results show that, for both selective oxidation to butadiene and total oxidation to  $\text{CO}_2$ , the rate constant for butene-1 is greater than that for butene-2, and the rate constants of isomerization of butene isomers are somewhat smaller than those of selective oxidation, but of the same order of magnitude. Over the ferrite catalyst, nonlinear regression of the kinetic data gives the estimated pressure dependencies for selective oxidation to be 1.0 in butene and 0.25 in oxygen, while those for total oxidation are 0.96 and 0.40 respectively. These parameters were found to be highly sensitive in the regression analysis, and the difference in pressure dependencies seems to imply a difference in the nature of the active sites for the two types of oxidation, explaining the drop in selectivity in butadiene formation with increasing oxygen partial pressure. The selective oxidation rate constants for the three butene isomers are nearly the same in magnitude, although the one for c-butene-2 is perceptibly greater. The isomerization rate constants for the butenes are all significantly lower, with the one for geometric isomerization greater than that for double bond migration. The sequence of combustion rate constants is c- and t-butene-2 > butadiene > butene-1.

Based on these estimated parameters, the effect of butene isomeric composition of a feed on the performance of the oxidative dehydrogenation process is discussed. It is also suggested that the isomerization may proceed through the carbonium ion mechanism over Bi-Mo, but through the allyl desorption mechanism over ferrite. The rate determining step for the selective oxidation could be inferred as the cleavage of the first H atom to form allyl for Bi-Mo, but for ferrite, the rate determining step is not the same as that for Bi-Mo.

AUTHOR: ZHAO Chengwen [6392 2052 2429]  
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ORG: Dalian Institute of Chemical Physics, Chinese Academy of Sciences

TITLE: "Influence of Some Factors on the Quantum Yield of Hydrogen Photogeneration"

SOURCE: Beijing CUIHUA XUEBAO [JOURNAL OF CATALYSIS] in Chinese Vol 6 No 1, Mar 85 pp 37-43

TEXT OF ENGLISH ABSTRACT: The irradiation of an aqueous solution containing a photosensitizer (proflavine or  $\text{Ru}(\text{bpy})_3^{2+}$ ), a relay ( $\text{MV}^{2+}$  or  $\text{Rh}(\text{bpy})_3^{3+}$ ), an electron donor (TEOA or EDTA) and a catalyst ( $\text{K}_2\text{PtCl}_4$ ) by visible light to generate hydrogen has been studied. The hydrogen quantum yield depends not only on the nature of the photocatalytic system, but also on the experimental conditions, such as the concentration of the photosensitizer, pH of the solution, the wavelength of incident light, etc.

The influence of the pH on the quantum yield of hydrogen photogeneration ( $\Phi_{\text{H}_2}$ ) for the three photocatalytic systems investigated, proflavine- $\text{MV}^{2+}$ -EDTA- $\text{K}_2\text{PtCl}_4$ , proflavine- $\text{Rh}(\text{bpy})_3^{3+}$ -TEOA- $\text{K}_2\text{PtCl}_4$ , and  $\text{Ru}(\text{bpy})_3^{2+}$ - $\text{Rh}(\text{bpy})_3^{3+}$ -TEOA- $\text{K}_2\text{PtCl}_4$ , showed that the optimum pH values were located at 4.0-5.0, 7.5-8.1 and 7.5-8.1 respectively.

Because of the concentration quenching and excimer formation, there is an upper limit to photosensitizer concentration. If the upper limit is exceeded,  $\Phi_{\text{H}_2}$  will be lowered. Experimental results show that the concentration limits affecting  $\Phi_{\text{H}_2}$  for different photosensitizers in the same relay/donor/catalyst system are quite different, and for the same photosensitizer in different systems the concentration limits are also different. The difference in concentration may be more than one order of magnitude.

It is interesting to note that in the  $\text{MV}^{2+}$ -EDTA- $\text{K}_2\text{PtCl}_4$  system, by using two photosensitizers ( $\text{Ru}(\text{bpy})_3^{2+}$  and proflavine) with superposed absorption bands,  $\Phi_{\text{H}_2}$  is generally lowered. But when the concentration of the main photosensitizer goes beyond the upper limit mentioned above, the double photosensitizer system gives better results than either single photosensitizer system.

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ORG: East China Institute of Chemical Technology, Shanghai

TITLE: "Kinetics of the Hydroisomerization of n-Pentane over Pd/H-Mordenite"

SOURCE: Beijing CUIHUA XUEBAO [JOURNAL OF CATALYSIS] in Chinese Vol 6 No 1,  
Mar 85 pp 44-49

TEXT OF ENGLISH ABSTRACT: The kinetics of n-pentane hydroisomerization over Pd/H-Mordenite in a temperature range of 200-300°C, total pressure of 20-80 kg/cm<sup>2</sup>, and H<sub>2</sub>/n-pentane mole ratio of 2-12 has been studied in a combination unit of a catalytic pressure microreactor and a gas chromatograph.

The results reveal that the conversion of n-pentane decreased with the total pressure increase from 20 to 80 kg/cm<sup>2</sup>, when the H<sub>2</sub>/n-pentane mole ratio and weight space velocity were kept constant. The rate of reaction followed a first-order, reversible reaction between n-pentane and i-pentane, while the partial pressures of hydrogen and hydrocarbon were kept constant. The influence of temperature on the apparent reaction rate constant was determined from an Arrhenius' type plot, with the apparent activation energy calculated being 36±1.2 Kcal/mole under pressures of 20-50 kg/cm<sup>2</sup>. Experiments were carried out at various partial pressures of n-pentane and hydrogen with total pressure and contact time being kept constant. Some experiments were also performed at constant partial pressure of n-pentane or hydrogen. The apparent forward rate constant of the first-order, reversible reaction decreased with the increase of either the hydrocarbon or hydrogen partial pressure. It is clear that the effects of the hydrocarbon partial pressure and of the hydrogen partial pressure on the rate constant are quite different. For example, the rate constant changed from 0.1137 to 0.2076 when the H<sub>2</sub>/n-pentane mole ratio varied from 4 to 12 at 260°C and 30 kg/cm<sup>2</sup> total pressure. The pressure dependency of the apparent rate constant is compatible with a dual-site model:

$$k = \frac{k_p K_p}{(1 + K_p P_{C_5} + K_n P_{H_2})^n} \quad n=1 \text{ or } 2$$

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TITLE: "Investigation of the Characteristics of Oxygen in  $\text{La}_{1-x}\text{Ca}_x\text{MnO}_3$  by TPD Technique"

SOURCE: Beijing CUIHUA XUEBAO [JOURNAL OF CATALYSIS] in Chinese Vol 6 No 1, Mar 85 pp 83-86

TEXT OF ENGLISH ABSTRACT: The properties and performances of  $\text{La}_{1-x}\text{Ca}_x\text{MnO}_3$  catalysts for the oxidation of ammonia have been investigated in our laboratory. In the report, the results of oxygen TPD from  $\text{La}_{1-x}\text{Ca}_x\text{MnO}_3$  ( $x$  from 0 to 1) after oxygen treatment or after the ammonia oxidation reaction are given. It was found that a minimum oxygen desorption appeared at  $x = 0.5$ . The highest signal intensity was also observed at  $x = 0.5$  for this series of compound oxides from ESR measurement. It is believed that the  $\text{Mn}^{4+}\text{-O-Mn}^{3+}$  reaches its maximum concentration at this composition of oxides and we are convinced that this kind of cluster is the most stable one. The desorption of oxygen from a La-rich catalyst after the ammonia oxidation reaction was obviously less than that after oxygen treatment. However, after the same treatments, desorption of oxygen from the Ca-rich catalyst decreased slightly. It was shown that the change of the Mn valence on catalyst surfaces with different  $x$  values ( $\leq$  or  $> 0.5$ ) was different, i.e., a higher oxidation state was maintained on the Ca-rich catalyst surface and a much lower oxidation state was found on the La-rich catalyst surface in the reaction of ammonia oxidation.

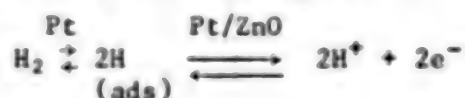
AUTHOR: HONG Zupei [3163 4371 1014]  
et al.

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TITLE: "Study of the Electrical Conductivity of Pt/ZnO Catalysts"

SOURCE: Beijing CUIHUA XUEBAO [JOURNAL OF CATALYSTS] in Chinese Vol 6 No 1,  
Mar 85 pp 87-90

TEXT OF ENGLISH ABSTRACT: An in situ investigation of the electrical conductivity of Pt/ZnO catalysts during or after hydrogen treatment at room temperature and  $\geq 300^\circ\text{C}$  has been performed. It was observed that the electrical conductivity increased instantaneously by six orders of magnitude when the Pt/ZnO catalyst pellet was exposed to hydrogen at room temperature. The electrical conductivity of the catalyst returned to its original value when the pellet was purged with nitrogen or evacuated at room temperature to remove the hydrogen. This phenomenon can be explained as the result of the occurrence of hydrogen spillover and back-spillover on Pt/ZnO, i.e.,



However, for the catalyst sample reduced at high temperatures ( $\geq 300^\circ\text{C}$ ), the change in electrical conductivity became irreversible, demonstrating that part of the interstitial hydrogens turned out to be bonded to the crystalline lattice. This phenomenon seems to be similar to that for the Pt/TiO<sub>2</sub> catalyst. However, when compared with Pt/TiO<sub>2</sub>, Pt/ZnO was more susceptible to H<sub>2</sub> and CO gases.



AUTHOR: CHEN Yanxin [7115 3601 7451]  
et al.

ORG: Dalian Institute of Chemical Physics, Chinese Academy of Sciences

TITLE: "Photocatalytic Reaction of Ethylene and Water over Pd/TiO<sub>2</sub>"

SOURCE: Beijing CUIHUA XUEBAO [JOURNAL OF CATALYSIS] in Chinese Vol 6 No 1,  
Mar 85 pp 91-94

TEXT OF ENGLISH ABSTRACT: The photocatalytic reaction of ethylene and water by various Pd/TiO<sub>2</sub> catalyst samples suspended in aqueous solution was carried out at 60°C. It was shown that ethylene and water could be converted to hydrogen and organic oxygen compounds, such as ethyl alcohol and acetaldehyde, as the main oxidation products over specially prepared Pd/TiO<sub>2</sub> catalysts under irradiation, and only a small amount of CO<sub>2</sub> was found. Within a six-hour period of photoreaction, the CO<sub>2</sub> detected was less than 2 μmol, while the total oxidation products accumulated came to ca. 90 μmol.

It was also found that the photocatalytic activities and selectivities of Pd/TiO<sub>2</sub> catalysts were strongly dependent not only on the preparation methods, but also on the subsequent treatment conditions. After treatment with argon or hydrogen at different temperatures, the catalyst's yield of hydrogen was greatly increased but no obvious change in selectivity was observed. However, the ratio of the oxidation products, ethanol to acetaldehyde, was altered, and the catalyst treated with hydrogen changed the ratio of ethanol to acetaldehyde from 2:1 (untreated catalyst) to 1:2.

The experimental results suggest that the photocatalytic reaction of ethylene and water to obtain hydrogen and organic oxygen compounds is possible by using an appropriate catalyst, and that the states of active components of Pd/TiO<sub>2</sub> catalyst are very important in activating the ethylene molecules and promoting the photolysis of water molecules.

9717

CSO: 4009/1012

Control Systems

AUTHOR: YAN Weiyong [0917 0251 0516]

ORG: Institute of Systems Science, Chinese Academy of Sciences

TITLE: "Quantitative Analysis for the Structural Stability of Linear Control Systems"

SOURCE: Beijing XITONG KEXUE YU SHUXUE [JOURNAL OF SYSTEMS SCIENCE AND MATHEMATICAL SCIENCES] in Chinese Vol 5, No 2 [Apr] 85 pp 133-144

TEXT OF ENGLISH ABSTRACT: The structural stability of linear control systems with exodisturbance in the time and frequency domain by the method of perturbation analysis for matrices are analyzed quantitatively. Several upper-bound estimates of tolerant perturbation for open-loop systems are given, which can be calculated conveniently. Hence, there is quantitative realization for the idea of robustness in the internal model principle.

AUTHOR: DI Angzhao [3695 2491 3564]

ORG: Institute of Systems Science, Chinese Academy of Sciences

TITLE: "A New Result on the Iterative Algorithm for Adaptive Array Processing With Correlated and Nonstationary Noise"

SOURCE: Beijing XITONG KEXUE YU SHUXUE [JOURNAL OF SYSTEMS SCIENCE AND MATHEMATICAL SCIENCES] in Chinese Vol 5, No 2 [Apr] 85 pp 151-[161]

TEXT OF ENGLISH ABSTRACT: A new iterative algorithm for adaptive array processing with correlated and nonstationary noise is proposed which does not need to keep the estimates  $W_k$  in a bounded area. Under some simple conditions we have proved the convergence of the algorithm in the sense of almost everywhere.

CSO: 4009/1030

JPRS-CST-85-022  
11 July 1985

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TITLE: "Some Statistical Patterns of Chinese Tone for Disyllable and Its Application on Synthesis of Speech by Rule"

SOURCE: Beijing SHENGXUE XUEBAO [ACTA ACUSTICA] in Chinese Vol 10, No 2, Mar 85 pp 73-84

TEXT OF ENGLISH ABSTRACT: Although the pitch is different in absolute value, its contours corresponding to a particular Chinese tone should have a similar pattern which is a distinctive feature in speech perception. This is an important feature of Chinese language itself.

A lot of work on the pitch patterns of Chinese tones has been done, but most of them were only qualitative or oversimplified. It is somewhat difficult to apply those results directly to design of speech synthesis by rule. This paper has given 15 new statistical results of tone patterns of Chinese disyllable and each pattern can be formulated simply by a normalized function  $P(t)$  in time domain which is directly proportional to  $T_{\max}$  and inversely proportional to  $T_0(t)$ , where  $T_{\max}$  is the reciprocal of the lowest fundamental frequency in the syllable and  $T_0(t)$  the pitch period at time  $t$ .

The pattern  $P(t)$  can directly be used for the synthesis of Chinese speech by rule and it is helpful to improve the naturalness of synthesis speech.

CSO: 4009/1032

JPRS-CST-85-022  
11 July 1985

AUTHOR: XIA Phijie [1115 1014 2638]  
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ORG: All of Institute Photochemistry, Chinese Academy of Sciences

TITLE: "A Study on the Influence of Photon Noise on the Photographic Granularity by a Monte Carlo Computer Simulation Technique"

SOURCE: Beijing GANGUANG KEXUE YU GUANGHUAXUE [PHOTOGRAPHIC SCIENCE AND PHOTO-CHEMISTRY] in Chinese No 2, May 84 pp 24-33

TEXT OF ENGLISH ABSTRACT: A probabilistic model for computer simulation is used to simulate an emulsion layer in which the silver halide grains are randomly distributed. The latent image formation in grains during exposure and granularity measurement for the emulsion layers are studied as well. By means of a regression analysis approach, the comparisons between the granularities which arise from a random distribution of grains at different grain spatial densities and those of the emulsion layers after exposure to light or one-quantum-threshold radiation are made. It is concluded that if at each stage of the photographic process each grain in an emulsion layer is independently involved in various reactions concerned, i.e. there is no correlation between grains, there exist no detectable contribution of photon noise to the photographic granularity.

CSO: 4009/1033

AUTHOR: SONG Wenmiao [1345 2429 8693]  
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TITLE: "IMPATT Diode Simulation"

SOURCE: Beijing DIANZI KEXUE XUEKAN [JOURNAL OF ELECTRONICS] in Chinese Vol 6,  
No 5, Sep 84 pp 400-408

TEXT OF ENGLISH ABSTRACT: A set of programs is established for IMPATT diode simulation. It can be used to calculate the DC small signal and large signal solution of the IMPATT diodes made of different materials and having different doping profiles. The physical principles, numerical methods and program designs are discussed, and the half-implicit method is presented in detail. Those programs can be used to simulate all kinds of transit-time devices, but only the calculating results of Si IMPATT diode are given.

CSO: 4009/1031



AUTHOR: SHAO Wenchang [6730 2429 2490]

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TITLE: "An Analysis and A Dynamic Testing Method of Microwave QPSK Modulation"

SOURCE: Beijing DIANZI KEXUE XUEKAN [JOURNAL OF ELECTRONICS] in Chinese Vol 6, No 5, Sep 84 pp 382-380

TEXT OF ENGLISH ABSTRACT: Using the clockwise or anticlockwise stepping pulse code signal, the characteristics of general QPSK modulation are analyzed. The spectrums in several operational conditions and the admittance formulas of related two modulation circuits are given. Several typical examples of QPSK modulation are calculated. The results are used to decide the modulation effect and phase error, and also to adjust the QPSK modulator under the dynamic testing. The experimental results are in agreement with the theoretical calculations. An X band QPSK modulator is also presented. The maximum phase error is less than  $4^\circ$ , insertion loss less than 4 dB, phase accuracy near  $\pm 0.1^\circ$  and transmission data rate up to 34 Mb/s.

CSO: 4009/1031

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ORG: Institute of Spacecraft System Engineering, The Chinese Academy of  
Space Technology and Beijing Institute of Information and Control

TITLE: "Contoured Beam Antennas of Offset Paraboloid Reflector--Circularly  
Polarized Feed Array"

SOURCE: Beijing DIANZI KEXUE XUEKAN [JOURNAL OF ELECTRONICS] in Chinese Vol 6,  
No 5, Sep 84 pp 343-350

TEXT OF ENGLISH ABSTRACT: The approach for the Jacobi-Bessel series expansion  
of the physical optics radiation integral studied by R. Mittra et al is ex-  
tended to the case of circularly polarized illumination, and a computation  
technique for the circularly polarized contoured beam of the offset reflector  
antennas is analyzed. This paper deals with the following problems: the  
mathematical model of circularly polarized feed, the equivalent distribution  
of reflector projected aperture, the secondary radiation field formula of  
offset paraboloid reflector and the EIRP computation formula of the contoured  
beam. The EIRP/W contour-plot for the western zone coverage of the territory  
of China is given (illumination by 7-element feed array).

CSO: 4009/1031

Laser

AUTHORS: MA Zuguang [7456 4371 0342]  
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ORG: Harbin Industrial University

TITLE: "Laser Oscillation at 2.50-2.56  $\mu$  in Na<sub>2</sub> by UV Laser Excitation"

SOURCE: Shanghai YINGYONG JIGUANG [APPLIED LASER] in Chinese Vol 5 No 1,  
Feb 85 pp 21-24, 20

TEXT OF ENGLISH ABSTRACT: The cascade transition of Na<sub>2</sub> at wavelengths of 2.5  $\mu$  and 9100 Å was observed in the excitation of sodium vapor by an XeF laser (3511 Å) and N<sub>2</sub> laser (3371 Å). The bound-bound transition structures of the region in 2.50-2.56  $\mu$  and possible intermediate state of the cascade transition are discussed. The laser oscillation and tunable effect were obtained.

7755

CSO: 4009/174

Laser

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GAO Rufang [7559 1172 5364]

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TITLE: "Using Laser Optoacoustic Spectroscopy To Study the Characteristics of Doping Density and Electrical Resistivity of Semiconductor Materials"

SOURCE: Shanghai YINGYONG JIGUANG [APPLIED LASER] in Chinese Vol 5 No 1, Feb 85 pp 25-28

TEXT OF ENGLISH ABSTRACT: The correlation between the absorption coefficient of silicon at the wavelength of  $10.6\ \mu$  and its doping density of electrical resistivity was determined experimentally using a combined system with a piezoelectric transducer and a photoacoustic cell. The result of absorption by a lower-dosage implanted silicon wafer and the distribution of doping density of the sample are described.

7755

CSO: 4009/174

## Laser

AUTHORS    LIU Jinshou [0491 6855 4849]  
            ZOU Zhijie [6760 1807 3381]

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TITLE:     "Microcrystalline Glass He-Ne Laser Tube"

SOURCE:   Shanghai YINGYONG JIGUANG [APPLIED LASER] in Chinese Vol 5 No 1,  
            Feb 85 pp 36-38

TEXT OF ENGLISH ABSTRACT: The factors of influence on stability of He-Ne laser output power are discussed. A new material, microcrystalline glass, is used as the envelope of an He-Ne laser for the first time. The microcrystalline glass which can be cut is used as the adjustment of the mirror. The configuration of the laser tube is half-outside cavity and coaxial type. Three wavelengths of 6328 Å, 1.15 μ, 3.39 μ laser light and output stability of ± 2 percent were obtained.

7755  
CSO: 4009/173



## Laser

AUTHOR: WANG Susheng [3769 5685 3932]

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TITLE: "Satellite Laser Ranging System With a Precision of Better Than 10 cm"

SOURCE: Shanghai YINGYONG JIGUANG [APPLIED LASER] in Chinese Vol 5 No 1,  
Feb 85 pp 12-16

TEXT OF ENGLISH ABSTRACT: A high-precision satellite laser ranging system was developed in our institute. Our objectives and design considerations are described. A ruby laser operating under pulse-time-modulation, constant ratio gating technique and high resolution counter were incorporated in the system which gained a precision of better than 10 cm.

7755

CSO: 4009/173

Laser

AUTHOR: ZHANG Zebo [1728 3419 3258]

ORG: Institute of Physics, Chinese Academy of Sciences

TITLE: "New High-Power TEM<sub>00</sub> CW CO<sub>2</sub> Laser Amplifier Operated by Turbulence Flow"

SOURCE: Shanghai YINGYONG JIGUANG [APPLIED LASER] in Chinese Vol 5 No 1, Feb 85 pp 6-8, 28

TEXT OF ENGLISH ABSTRACT: An analytical and experimental investigation on the lensing effect of CO<sub>2</sub> laser plasma by introducing turbulence in flow is presented. The turbulence greatly increases the effective ambipolar diffusion and heat conductivity of the laser gas. The increase in ambipolar diffusion causes the electron density profile to be more uniform over the cross section, so that the ohmic heating is more uniform. The calculation indicates that the thermal lensing effect in a fast-flow CO<sub>2</sub> laser amplifier, for example 2 meter length, produces a focal length in the order of magnitude of -200 meters. In the experimental observation, the focal length is -100 meters. These results have shown that the optimum configuration of a 10 meter length linear CO<sub>2</sub> laser amplifier for 5 kW output power is feasible without optical compensators.

7755

CSO: 4009/173

AUTHORS: CHEN Liyin [7115 7787 0692]  
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WU Zhongxiang [0702 0022 4382]

ORG: All of Institute of Mechanics, Chinese Academy of Sciences

TITLE: "Two-Dimensional Saturated Gain Distribution and Output Power in a Transverse-Flow Electric-Discharge CO<sub>2</sub> Laser"

SOURCE: Shanghai GUANGXUE XUEBAO [ACTA OPTICA SINICA] in Chinese Vol 5 No 2, Feb 85 pp 135-141

TEXT OF ENGLISH ABSTRACT: The two-dimensional distribution of saturated gain coefficient, some related physical parameters and their variation rules with the radiation intensities in a cavity are investigated. They are analyzed theoretically by the microscopic physical mechanism. Under three conditions or stable oscillation, the optical intensity distributions in the cavity are calculated respectively and the results are compared with each other. A simple method for selecting the optimum design parameters of a transverse laser is suggested.

7755

CSO: 4009/172

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SHEN Shize [3088 0013 3419]  
JIANG Rusheng [1203 1172 2573]  
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ORG: SUN and SHEN of the Institute of Oceanology, Academia Sinica; JIANG of the Qingdao Municipal Taidong Region Station of Environmental Protection and Detection and SUN of the Qingdao Municipal Institute of Scientific and Technological Information

TITLE: "Purification of Industrial Chromic Wastes by Chromatereducing Bacteria in Factory"

SOURCE: Beijing HAIYANG KEXUE [JOURNAL OF MARINE SCIENCE] in Chinese No 2, 9 Mar 85 pp 44-48

TEXT OF ENGLISH ABSTRACT: This paper reports the experiments of purifying the industrial chromic wastes from a small electroplating factory by the chromatereducing bacteria N-81001 isolated from marine mud, with a result of the Cr (VI) concentration being dropped to <0.5ppm. Thus, this simple and inexpensive process for purification industrial chromic wastes which we recommended about 2 years ago can be used in factory. Some characteristics of these bacteria have also been studied.

12949  
CSO: 4009/238

Marine Science

AUTHOR: WAN Zhaozhong [8001 5128 1813]

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TITLE: "Investigation and Preliminary Evaluation of Contamination in Shenzhen Bay"

SOURCE: Beijing HAIYANG KEXUE [JOURNAL OF MARINE SCIENCE] in Chinese No 2, 9 Mar 85 pp 40-43

TEXT OF ENGLISH ABSTRACT: This paper reports the results of two investigations conducted in Shenzhen Bay, which showed that water here was of good quality if not for pollution. Contents of Cd, Pb in Shenzhen Bay sediments were higher than those in Osaka Bay, Japan; contents of Cr, Cu and Cd found in Ostrea were higher than those in the Atlantic Ocean. Proposal of remedy is suggested.

12949

CSO: 4009/238



Marine Science

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XU Lijun [1776 7787 0689]  
LIU Xingjun [0491 5281 0193]

ORG: Institute of Oceanology, Academia Sinica

TITLE: "The Relationship Between the Preparation Conditions of Hydroxide Aluminium-clam Shell Powder-potassium Chloride Composite Agent-enriched and the Enrichment of Uranium"

SOURCE: Beijing HAIYANG KEXUE [JOURNAL OF MARINE SCIENCE] in Chinese No 2, 9  
Mar 85 pp 32-34

TEXT OF ENGLISH ABSTRACT: Test results showed that the enrichment of uranium was closely related to the preparation conditions of hydroxide aluminium-clam shell powder-potassium chloride composite agent-enriched. An optimum condition of the preparation of hydroxide aluminium-clam shell powder-potassium chloride composite agent-enriched is suggested in this paper.

12949  
CSO: 4009/238

Medical Science

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TITLE: "Rapid Determination of Thermolabile Intestinotoxin of Escherichia Coli Accompanied With Coagulation Test (Excerpt)"

SOURCE: Beijing JIEFANGJUN YIXUE ZAZHI [MEDICAL JOURNAL OF CHINESE PEOPLE'S LIBERATION ARMY] in Chinese No 2, 20 Apr 85 pp 126-127

ABSTRACT: An important pathogen of colliquative diarrhea is Escherichia coli (producing intestinotoxin), whose pathogenicity is closely related to the produced thermolabile intestinotoxin (LT) and thermostabile intestinotoxin (ST); therefore, toxin determination is the necessary step in diagnosing diarrhea caused by Escherichia coli. Although the Biken test is simple and convenient, yet test results take 3 to 4 days. Only 6 to 7 hours are required for a rapid coagulation test for Escherichia coli (which produces LT) accompanied with Staphylococcus aureus. Biken No 2 is used as liquid culture medium; solid medium can also be used. Staphylococcus aureus is then susceptible to anti-LT serum. The clear, upper layer of cell solute is collected; with the susceptible Staphylococcus aureus, coagulation on a slide can be observed. The susceptible Staphylococcus aureus can be kept four months in a refrigerator. The first draft of the paper was received in August 1984; the final, revised draft was received in January 1985.

Medical Science

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TITLE: "Analysis of Long-term Therapeutic Efficacy of 57 Cases of Firearm Wounds to Peripheral Nerve (Excerpt)"

SOURCE: Beijing JIEFANGJUN YIXUE ZAZHI [MEDICAL JOURNAL OF CHINESE PEOPLE'S LIBERATION ARMY] in Chinese No 2, 20 Apr 85 pp 132-133

ABSTRACT: This paper reports on 2 years' follow-up visits on 57 cases of firearm wounds to 74 nerves. Surgical procedures are described: anesthesia, exposing of injured nerve, excision of scars in nerve, suture, avoiding of torsion on nerve bundle, hemostasis and gypsum cast immobilization of injured limb for 3 weeks. As to the analysis of long-term therapeutic efficacy, the recovery rate for the transplantation of the severed nerve in the upper limb is 68.8 percent; it is 100 percent for the interfascicular transplantation of nervus radialis. For the lower limb, the recovery rate is 62.6 percent. In the relationship between the cause of injury and therapeutic efficacy, the recovery rate is 71.4 percent for the restoration of nerves damaged by shell fragments; the rate is 54.3 percent for bullet wounds. The restoration of limb movement is better the further the wound is from the trunk. The optimal time for nerve restoration is 3 weeks to 3 months after the wound has healed. The recovery rate for interfascicular transplantation is 66.7 percent for 48 nerves. The longer the transplanted nerve, the lower is the recover rate. The first draft of the paper was received in August 1983; the final, revised draft was received in December 1984.

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TITLE: "The Structure of Two New Anisomycin Type Antibiotics"

SOURCE: Shanghai HUAXUE XUEBAO [ACTA CHIMICA SINICA] in Chinese No 1, Jan 85  
p 98

TEXT OF ENGLISH ABSTRACT: Two new anisomycin family antibiotics anisomycin C and D were isolated from *Actinomyces* C-4826. Their structure were elucidated by  $^1\text{H}$  and  $^{13}\text{C}$ NMR and MS spectral analysis to be 2-p-methoxy-phenyl-3-butyroxy-hydroxy-pyrrolidine (4) and 2-p-methoxy-phenyl-3-isovaleroxy-4-hydroxy-pyrrolidine (5) respectively.

The structure of anisomycin D was further confirmed by alkaline hydrolysis to desacetylanisomycin. Anisomycin A was found to be the same as anisomycin previously described in the literature and anisomycin B was not characterized because of minor amount.

12949  
CSO: 4009/221

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TITLE: "Detection of the Thermolabile Toxin Produced by Enterotoxigenic  
E. Coli with a Genetic Probe and the Solid Phase Radio-immunological Assay"

SOURCE: Beijing JIEFANGJUN YIXUE ZAZHI [MEDICAL JOURNAL OF CHINESE PEOPLE'S  
LIBERATION ARMY] in Chinese No 2, 20 Apr 85 pp 88-90

TEXT OF ENGLISH ABSTRACT: This paper reports two methods of detecting the thermolabile toxin produced by Escherichia coli--a genetic probe and the solid phase radio-immunological assay. The former is the application of a <sup>32</sup>P-labeled probe of B subunit DNA prepared from the Hind III restriction fragment of LT-encoding DNA, and the latter uses CNBr-activated paper as the carrier and <sup>125</sup>I-SPA to substitute for the secondary antibody. The methods were applied to 160 strains of E. coli isolated from patients suffering from infantile diarrhea. The results showed that 42 of the 160 strains could produce the thermolabile toxin. These two methods are not only sensitive and specific, but also beneficial to epidemiological survey and clinical diagnosis since the testing bacteria are decomposed on the nitrocellulose membrane, therefore enabling hundreds of samples to be examined in one test.



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et al.

ORG: Department of Microbiology, Fourth Military Medical College, Xi'an

TITLE: "Establishment of the Hybridoma Cell Lines Secreting Monoclonal Antibodies Against the Herpes Simplex Virus"

SOURCE: Beijing JIEFANGJUN YIXUE ZAZHI [MEDICAL JOURNAL OF CHINESE PEOPLE'S LIBERATION ARMY] in Chinese No 2, 20 Apr 85 pp 91-94

TEXT OF ENGLISH ABSTRACT: Five hybridoma cell lines producing a monoclonal antibody (McAb) against herpes simplex virus (HSV) were established by fusing the mouse myeloma cell line Sp2/0 with the spleen cells of CxS/1 mouse immunized with the HSV-1 SM44 strain. A series of clonizations was made with these hybridoma cell lines and the positive clone rate of all five cell lines was 100 percent. The hybridoma cell lines can steadily secrete McAb after being cultured for four months in vitro. The five McAb can react with HSV-1 and HSV-2 by ELISA and/or IF. It is suggested that the specificity of the five McAb is type-common. The McAb titer in culture supernatants was  $10^{-2}$ ~ $10^{-3}$  and  $10^{-4}$ ~ $10^{-7}$  in mouse ascitic fluids.

AUTHOR: YU Ping [0060 1627]  
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ORG: Institute of Aviation Medicine, PLA

TITLE: "Test of Aerobatic Acceleration and Pilot's +Gz Endurance"

SOURCE: Beijing JIEFANGJUN YIXUE ZAZHI [MEDICAL JOURNAL OF CHINESE PEOPLE'S  
LIBERATION ARMY] in Chinese No 2, 20 Apr 85 pp 123-125

TEXT OF ENGLISH ABSTRACT: This paper analyzes statistically the parameters of acceleration and heart rates in 905 aerobatic maneuvers of 88 sorties. The results indicate that the G levels, rates of increase and duration of acceleration in tactical flight training are higher and longer than those in routine flight training. There is a significant correlation between the pilot's heart rate and the magnitude of G levels. The pilot's endurance when operating the aircraft actively was 1.4G higher, on the average, than that of the centrifuge runs. After anti-G physiological training, the endurance could be increased by an average of 2.24G by means of using the anti-G suit and L-1 maneuver. Endurance was increased by an average of 1.18G when compared with that prior to physiological training.

9717

CSO: 4009/250

Optics

AUTHORS: YAO Jianquan [1202 1696 6893]  
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ORG: Both of Precision Instrument Department, Tianjin University

TITLE: "Intracavity Frequency Doubling by Gaussian and Gaussian-Like Beams  
at High Conversion Efficiency"

SOURCE: Shanghai GUANGXUE XUEBAO [ACTA OPTICA SINICA] in Chinese Vol 5 No 2,  
Feb 85 pp 142-150

TEXT OF ENGLISH ABSTRACT: Some valuable results are presented of frequency doubling, considering the transversal variation of the amplitude and the depletion of the fundamental wave power. By solving the three-dimensional coupling wave equation, the most common expressions of second harmonic wave power are derived. The influences of the fundamental wave power and the crystal length are discussed. As a special example the expressions of second harmonic wave power at low conversion efficiency are given.

As a summary, eight expressions of the second harmonic wave power at different cases are listed, in which five cases come from this paper.

Finally, a new way of dealing with the intracavity frequency doubled laser is given. In our model the power loss due to second harmonic generation is considered as a variable loss for the fundamental wave power which is circulating in the cavity. By solving the rate equations numerically, the optimum parameters of the cavity and of the frequency doubling crystal are found.

This paper was presented at CLEO '84, Anaheim, California, 21 June 1984.

7755  
CSD: 4909/172

Optics

AUTHORS: XIE Jianping [6200 1696 1627]  
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ORG: All of Physics Department, China Scientific and Technical University

TITLE: "Measuring the Coherence of Optical Fields by Holographic Shearing Interferometry"

SOURCE: Shanghai GUANGXUE XUEBAO [ACTA OPTICA SINICA] in Chinese Vol 5 No 2,  
Feb 85 pp 103-106

TEXT OF ENGLISH ABSTRACT: A method of measuring the coherence of optical fields by holographic shearing interferometry is described. Some experimental results are given on the spatial and temporal coherence of incoherent sources with the example of Cu-vapor laser beam coherence measurement. Also given is a brief discussion on the applications of the method.

7755

CSO: 4009/172

## Optics

AUTHOR: WU Shudong [0124 2885 2639]

ORG: Shanghai Institute of Optics and Precision Machinery, Chinese Academy of Sciences

TITLE: "Polarization Fringe Scanning Interferometer"

SOURCE: Shanghai GUANGXUE XUEBAO [ACTA OPTICA SINICA] in Chinese Vol 5 No 2, Feb 85 pp 97-102

TEXT OF ENGLISH ABSTRACT: Polarization encoding of phase objects may convert phase measurements to polarization measurements and realize polarization fringe scanning. Two kinds of linear polarization encoders are pointed out. A polarization fringe scanning point diffraction interferometer is proposed. With this technique the disadvantages of point diffraction interferometers may be avoided. The analyses of the scanning error and its correction are also given. Preliminary experiments confirmed the technique.

7755

CSO: 4009/172



AUTHOR: XIE Zhiming [6200 2737 6900]  
et al.

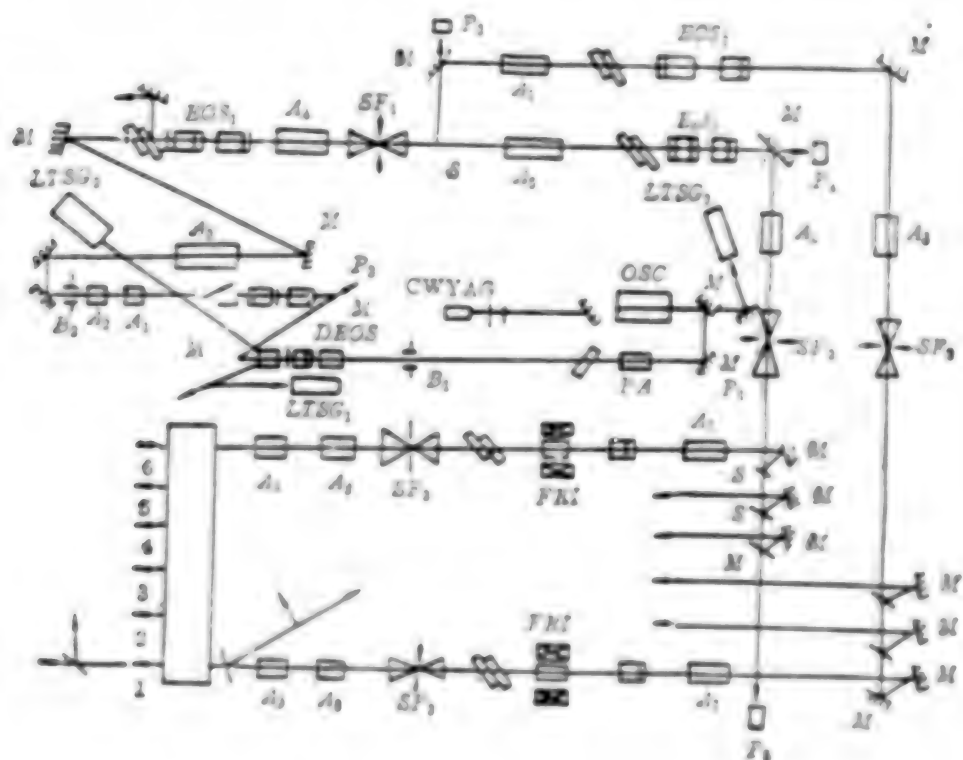
ORG: Shanghai Institute of Optics and Fine Mechanics, Academia Sinica

TITLE: "Progress in Six Beam Sub-nanosecond Nd-glass Laser Facility"

SOURCE: Shanghai GUANGXUE XUEBAO [ACTA OPTICA SINICA] in Chinese Vol 5, No 3, Mar 85 pp 211-216

TEXT OF ENGLISH ABSTRACT: The paper reports the progress in our six beam subnanosecond Nd-glass high power laser facility. Now the improved laser system is able to generate pulses with the following parameters: Pulse width can be selected from four ranges: 100ps, 250ps, 400ps and 1ns; Pulse shape is controllable basically either in smooth mode or in modulated mode; Spectrum width is tunable in the ranges of  $\leq 1 \text{ \AA}$  and  $20\text{--}30 \text{ \AA}$ ; Output energy can be also chosen in the way that for a single beam it is  $5\text{--}10$  joules with pulse width of 250ps and is  $10\text{--}15$  joules with pulse width about 1ns;

The experimental data of long period operation stability are given at the end of the paper.



Schematic diagram of arrangement

12949  
CSO: 4009/216

Optics

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ORG: Shanghai Institute of Optics and Fine Mechanics, Academia Sinica

TITLE: "Study on ASE Characteristics of Excimer Laser"

SOURCE: Shanghai GUANGXUE XUEBAO [ACTA OPTICA SINICA] in Chinese Vol 5, No 3,  
Mar 85 pp 199-204

TEXT OF ENGLISH ABSTRACT: In this paper the transport equations of laser and ASE normalized fluxes are set up taking into consideration the influence of ASE on threshold condition and the output characteristics of XeCl laser oscillator. The analytic expressions of laser and ASE fluxes distribution and output power are obtained.

The results show that: (1) The threshold gain increases in consideration of ASE. (2) The ASE output decreases with cavity Q increases. (3) ASE flux can be suppressed effectively by choosing reflectivity of cavity mirror adequately. This has been proved by the measurement on the space coherence of XeCl excimer laser.

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CSO: 4009/216

Optics

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ORG: Suzhou Optical Instruments Factory

TITLE: "Study on the Optical System of the Waiting Type High-speed Camera"

SOURCE: Shanghai GUANGXUE XUEBAO [ACTA OPTICA SINICA] in Chinese Vol 5, No 3, Mar 85 pp 235-240

TEXT OF ENGLISH ABSTRACT: A new optical system of the waiting type high-speed camera with rotating mirror is presented in this paper. A new beam splitter system and a special framing lenses bank are employed in the camera. The camera can be used to combine with shadow and interferometric devices by means of simple optical attachments as well as to do frame and streak photography directly.

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CSO: 4009/216

AUTHOR: ZHANG Bing [1728 0393]  
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ORG: Anhui Institute of Fine Mechanics, Academia Sinica

TITLE: "Calculations of SHG Coefficients and Ultraviolet Absorption Edge of Barate Crystal"

SOURCE: Shanghai GUANGXUE XUEBAO [ACTA OPTICA SINICA] in Chinese Vol 5, No 3, Mar 85 pp 217-224

TEXT OF ENGLISH ABSTRACT: Barium borate ( $\beta$ -BaB<sub>2</sub>O<sub>4</sub>) is a new type of nonlinear optical crystal which was made by China for the first time. Its transparent range of 190-300nm and SHG coefficient of macroscopic crystal  $\chi_{ij}^{(2)} = 4.6 \times 10^{-9}$  e. s. u. have been shown by experiments. CNDO/S calculated value of  $\chi_{ij}^{(2)}$ , which was in good agreement with the experiments was obtained, however, the calculated ultraviolet absorption edges 90nm was far from the result of experiments.

In this paper we report one-electro energy spectra of some inorganic and organic aromatic rings based on FMO theory. Both calculated values of SHG coefficient and ultraviolet absorption edge for Barium borate crystal are in good agreement with the experiments.

Since there has been dispute on the position of ultraviolet absorption edge we also calculate it by using more accurate SCF-X<sub>2</sub>-SW method and the calculated result supports the EMO calculation mentioned above. The factors which determines the position of ultraviolet absorption edge and the values of the SHG coefficients are discussed briefly.

12949  
CSO: 4009/216

Optics

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TITLE: "Degenerate Four-wave Mixing in an Artificial Nonlinear Medium"

SOURCE: Shanghai GUANGXUE XUEBAO [ACTA OPTICA SINICA] in Chinese Vol 5, No 3,  
Mar 85 pp 225-228

TEXT OF ENGLISH ABSTRACT: In this paper degenerate four-wave mixing has been demonstrated using an artifivial nonlinear medium--a liquid suspension. Using laser pulses from SH of a Q-switched Nd:YAG laser system as pumping beam, the third-order nonlinear optical susceptibility  $\chi^{(3)}$  of the aerosols was measured which is greater than that of  $\text{CS}_2$  by a factor of 3. The decay time of the density grating was measured by using a continuous reading beam.

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